The Thesis Committee for Matthew Ryan Jeans
Certifies that this is the approved version of the following Thesis:

Breakfast Consumption in Low-Income Hispanic Elementary School-Aged Children: Associations with Anthropometric, Metabolic, and Dietary Parameters

APPROVED BY
SUPERVISING COMMITTEE:

Jaimie Davis, Supervisor

Heather Leidy

Breakfast Consumption in Low-Income Hispanic Elementary School-Aged Children: Associations with Metabolic, Anthropometric, and Dietary Parameters

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Matthew Ryan Jeans

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Abstract

Breakfast Consumption in Low-Income Hispanic Elementary School-Aged Children: Associations with Metabolic, Anthropometric, and Dietary Parameters

Matthew Ryan Jeans, M.S.N.S.

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Supervisor: Jaimie Davis

Objective: This study examined the associations of breakfast consumption (BC) with metabolic and anthropometric parameters and dietary intake in predominately low-income, Hispanic 3rd-5th grade students from sixteen elementary schools in Austin, TX.

Methods: Cross-sectional, baseline data were used from a subsample of TX Sprouts, a school-based gardening, nutrition, and cooking randomized controlled trial in sixteen elementary schools in Austin, TX, targeting 3rd-5th grade students. Anthropometric measurements included height, weight, body mass index, body fat percent via bioelectrical impedance, waist circumference, and blood pressure. Metabolic parameters included fasting plasma glucose, insulin, glycated hemoglobin, cholesterol, and triglycerides. Dietary quality and breakfast consumption patterns were assessed via two 24-hour dietary recalls. Breakfast was defined as a meal consumed before 10AM, accounting for ≥15% of daily energy. Participants were stratified into breakfast consumption groups (BCG): breakfast skippers, no breakfast on both recall days; intermittent breakfast consumers, breakfast consumed on one of two recall days; and regular breakfast consumers, breakfast consumed on both recall days. Analysis of covariance was used to examine relationships between BCG and anthropometric and metabolic parameters and dietary intake, with *a priori* covariates including age, sex, race and ethnicity, free and reduced lunch status, and daily energy intake.

Results: This study included 671 students (mean age 9y, 58% Hispanic, 54% female, 66% free/reduced Lunch, 17% breakfast skippers). No associations were observed between BCG and anthropometric or metabolic parameters. BC was associated with higher dietary quality, higher daily intake of protein and fiber, and lower daily intake of fat when compared to skipping. Skipping breakfast was associated with lower dietary quality, higher daily intake of fat, and lower daily intake of protein and fiber when compared to BC. However, BC was associated with higher daily intake of total and added sugars compared to skipping.

Conclusion: While BC was associated with higher dietary quality compared to skipping, it was not robust in eliciting positive responses in anthropometric or metabolic outcomes. Research is warranted to examine the effects of BC and composition on anthropometric and metabolic outcomes. This trial was registered at ClinicalTrials.gov (NCT02668744).

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Chapter 1: Literature Review

Childhood Obesity and Associated Disease Prevalence

While obesity prevalence in children and adolescents has risen to approximately 18.5% in the United States, those of Hispanic ethnicity are disproportionately affected at 25.8% compared to other racial and Hispanic-origin groups, such as non-Hispanic black (22.0%), non-Hispanic white (14.1%), and non-Hispanic Asian (11.0%) (1). Furthermore, a significant increase in the linear trend of obesity prevalence was observed in children 2 to 5 years of age from 2013-14 (9.4%) to 2015-16 (13.9%), suggesting children are becoming obese earlier in life (2). Obesity has been associated with the prevalence of other diseases and comorbidities, such as diabetes, hypertension, dyslipidemia, and metabolic syndrome, and an overview of studies pertaining to them can be found in **Table 1** (3).

The Centers for Disease Control and Prevention (CDC) reports that among U.S. children and adolescents, incidence of type 2 diabetes significantly increased from 2002-2015 among U.S. children and adolescents 10 to 19 years of age, with incidence significantly increasing during both the 2002-2010 and 2011-2015 periods for those of Hispanic origin (4). The latest estimates from 2018 suggest that 210,000 children and adolescents younger than 20 years of age have diagnosed diabetes (4). In the study DeBoer et al., Hispanic adolescents had higher fasting insulin levels, a precursor to diabetes, than their non-Hispanic white counterparts (5).

Examination of NHANES data from 1988-2008 has shown a steady increase in the prevalence of childhood hypertension and elevated blood pressure (6). In 2017, a study conducted by the CDC showed an estimated 1 in 25 youth (12-19 years) have hypertension while 1 in 10 have elevated blood pressure, with prevalence being higher in those with obesity (7). Furthermore, hypertension prevalence is higher among Hispanic children when compared to non-Hispanic white children (8). Childhood elevated blood pressure and hypertension have been linked to BMI status and type two diabetes, which is more prevalent in Hispanic children than type one diabetes (9, 10). Hypertension prevalence is higher in Hispanic adolescents than Hispanic children and underscores the need to treat and prevent elevated blood pressure earlier in life for Hispanic children (8).

From 2011-2014, 7.4% of children and adolescents had high total cholesterol, with prevalence being higher in those with obesity (11.6%) than overweight (6.9%) and normal weight (6.3%) (11). In addition, 13.4% of children and adolescents had low HDL cholesterol, with those of Hispanic origin having the highest prevalence at 15.6% (11). Similarly, prevalence of low HDL cholesterol was higher in those with obesity (33.2%) than overweight (14.8%) and normal weight (6.8%) (11). These results were consistent in Kit et al., which showed Hispanic children and adolescents having the highest prevalence of high total cholesterol and non-HDL cholesterol and low HDL cholesterol when compared to non-Hispanic white, black, and Asian populations (8). Furthermore, overweight and obese Mexican American children were shown to have higher prevalence of dyslipidemia (12).

Encompassing cardiometabolic risk factors such as obesity, diabetes, hypertension, and dyslipidemia, metabolic syndrome has become a condition worthy of study given the consistent rise in risk factors discussed. There are currently no standard guidelines to diagnose metabolic syndrome, particularly in children. However, various definitions have been suggested through previous research (13-18). Hispanic children had a higher rate of elevated waist circumference than other groups but similar rates for other risks as non-Hispanic whites, supporting the notion that diagnosing metabolic syndrome during childhood for these two populations could prove beneficial (19). A longitudinal study showed that individuals diagnosed with metabolic syndrome during childhood had 11.5 increased odds of developing diabetes 25 years later, contributing to risks included in metabolic syndrome (20). Cruz et al. showed that 68% of overweight Hispanic children (8-13 years) had two or more features of metabolic syndrome, with those having a family history of type two diabetes having an increased risk for cardiovascular disease and type two diabetes (14). Socioeconomic status is inversely associated with cardiovascular disease, and lower socioeconomic status in childhood increased metabolic syndrome risk in adulthood (21, 22). These implications highlight the need for further research in low-income populations, particularly in Hispanic populations.

Risk Factors for Childhood Obesity

Childhood and adolescent obesity prevalence is associated with inherited factors, such as birthweight and genetic disposition (23, 24). For example, Kapral et al. showed that high birthweight and large-for-gestational-age preterm children had higher BMI z-scores from kindergarten to second grade compared to their normal birthweight counterparts (23). In genetics, both a set and subset of single-nucleotide polymorphisms (WGRS97 and WGRS19, respectively) were associated with higher BMI at 6 years of age (WGRS97) and 9 years of age (WGRS19) (24). While these are but a couple of inherited examples, many behavioral factors, such as physical activity, screen time, sleep, and mother's breastfeeding practices are associated with weight management in children (23-28).

One study showed several early life risk factors contribute to higher childhood obesity prevalence in Hispanic children compared to non-Hispanic white and black children (29). These included pregnancy exposures, such as the mother smoking during early pregnancy and having prenatal depression; infancy exposures, such as rapid weight gain, nonexclusive breastfeeding, and consuming solid foods before 4 months of age; and early childhood exposures, such as low sleep duration, fast food intake, and having a television in the child's bedroom (29). Wang et al.

confirmed that breastfeeding for more than six months decreased risk for childhood obesity by 42% when compared to never breastfeeding (28). Furthermore, normal weight children achieve more moderate-to-vigorous activity than overweight and obese children (26), with other confirmatory analyses showing common correlates of sedentary and screen time being poor weight status, not meeting physical activity guidelines, and having a television or computer in the child's bedroom (27).

Other links to childhood overweight and obesity have included parental weight status, education level, and socioeconomic status (30-32). Upon examination of parental education and weight status, Moraeus et al. showed that childhood obesity prevalence was associated with higher parental weight status and low to medium levels of parental education (32). In a systematic review, most studies showed increased overweight and obesity prevalence in children and adolescents belonging to a low socioeconomic status (30). Likewise, residing in lower levels of urbanization has been associated with childhood overweight and obesity prevalence (32). The various obesity risk factors mentioned involve the individual, interpersonal, organizational, and community levels within the social ecological model, proving obesity to be a complex, multifaceted health concern.

Food Insecurity on Obesity Risk and Diet

The prevalence of food insecure households in the United States was 11.1% in 2018, with 7.1% of households having food insecure children, resulting in inadequate provisions of nutritious foods (33). Furthermore, rates of food insecurity were higher than the national average for Hispanic households (16.2%) (33). Food insecurity is not only higher in Hispanic households, but it is also associated with increased obesity prevalence in Hispanic children (34-36). A retrospective study showed that previous exposure to food insecurity during childhood and adolescence was associated with higher BMI in adulthood compared to those who had not experienced food insecurity (37).

While food insecurity has been directly associated with negative health outcomes, such as obesity, it has also been associated with dietary intake. One popular notion to explain this relationship is that food insecurity leads to increased consumption of inexpensive energy-dense foods that are often higher in carbohydrates and fat (38). Specifically, child food insecurity is associated with higher consumption of energy, fat, sugar, and lower consumption of vegetables (39). Similarly, food insecure children have lower Healthy Eating Index-2015 (HEI-2015) total scores when compared to food secure children (40). Studies report that food insecurity was associated with lower intake of protein rich foods, dairy products, and fruits; lower dietary diversity; and greater access to unhealthy foods, such as microwavable meals (41, 42).

Breakfast Consumption on Obesity and Metabolic Parameters

It is well established that dietary habits have a prominent role in weight management. Literature shows that total energy intake is positively associated with overweight and obesity, but one dietary pattern that has been shown to influence weight management and energy intake is breakfast consumption (43, 44). Specifically, breakfast consumption has been shown to predict and protect against overweight and obesity incidence (43) and improve weight management (45-54). While studies show regular breakfast consumption is associated with decreased overweight and obesity prevalence when compared to those who skip or irregularly consume breakfast, other factors contributing to this have begun to surface (45-49). O'Neil et al. found that BMI z-scores were lower from consumption of five different breakfast patterns compared to skippers, suggesting that type of breakfast consumed may serve an important role in achieving positive weight outcomes (50). Children who consume ready-to-eat cereal, cooked cereal, or quick breads for breakfast had significantly lower BMI compared to breakfast skippers and those who ate meat and eggs at breakfast (55). In addition, the study Van Lippevelde et al. sought to evaluate family dynamics and found that breakfast consumption frequency with family was inversely associated with BMI z-scores in children (56). Another study consisting of 8,332 children observed an increased risk of overweight and obesity in male and female youth (6-12 years of age) and female adolescents (12-17 years of age) when compared to regular breakfast consumers, suggesting regular breakfast consumption could be protective long-term in females (53).

Several metabolic and physiological benefits of breakfast consumption include improved lipid panels, blood pressure, and decreased fasting insulin (48, 57, 58). As a result, studies have shown breakfast consumption reduces cardiometabolic risk factors (43), including dyslipidemia (59), and metabolic syndrome in children (48, 57, 60, 61). Similar results were confirmed in a systematic review of 16,130 children that reported skipping breakfast was associated with worse lipid profiles and higher blood pressure, insulin resistance, and prevalence of metabolic syndrome (43). While many of these studies emphasize the negative outcomes of skipping breakfast, one highlighted that HDL cholesterol was higher in those who consumed breakfast daily when compared to those who did not (48).

Inconsistent Associations of Breakfast Consumption on Health Outcomes

Skipping breakfast has been shown to have negative impact on dietary patterns and quality; however, the studies regarding breakfast consumption aforementioned have shown conflicting results. For example, a couple of studies that showed regular breakfast consumption was associated with higher dietary intake and quality also showed that it was associated with higher intakes of saturated fats and “sweets”, with flavored milk being the most frequently consumed food (48, 62). These counterintuitive findings could be due to fortification of common breakfast foods (i.e. cereals, nutrition bars, etc.) that tend to be high in saturated fats and added sugars, while still providing vitamins and minerals that contribute to dietary quality. Deshmukh-Taskar et al. posed that consumption of milk at breakfast contributed to higher calcium intake observed in breakfast consumers when compared to breakfast skippers (63). Containing similar nutrients, flavored milk consumption has been associated with consuming more milk and meeting calcium recommendations compared to breakfast skippers (64). While breakfast consumption aids dietary quality, its consumption was also associated with high added sugar and saturated fat intake and low fiber intake (64).

Recent studies have shown null or positive associations between breakfast consumption and obesity prevalence (65-69). Fayet-Moore et al. (2016) showed breakfast consumption to be associated with lower overweight and obesity prevalence in children (46). However, one year later, Fayet-Moore et al. (2017) showed null associations between breakfast consumption and overweight and obesity prevalence in a similar cohort, highlighting the consumption of added sugar (66). A longitudinal study showed increased breakfast consumption to be associated with higher obesity incidence and prevalence following an intervention spanning two and a half years (69). These findings suggest that quantity and quality of foods consumed at breakfast may play a vital role in contributing to the potential benefits associated with breakfast consumption.

Breakfast Consumption on Daily and Subsequent Dietary Intake

Breakfast consumption is associated with meeting dietary intake recommendations and having superior overall diet quality in children (48, 63, 70). Independent of breakfast consumption, breakfast composition has been associated with varied dietary quality (62, 63). Measures of dietary quality included evaluation of micronutrients, specifically shortfall nutrients (i.e., vitamin E, calcium, magnesium, iron, and zinc), and use of the Nutrient Rich Foods Index and the USDA HEI-2015 (62, 63, 70). Higher diet quality is achieved from breakfast consumers having higher intake of foods, such as fruit, whole grains, and milk, resulting in superior nutrient intake to that of breakfast skippers (50, 65, 71, 72). Many studies have shown that those who consume breakfast have higher intake of dietary fibers and micronutrients (48, 62, 65, 66, 71, 73, 74). One of these studies showed that consuming a breakfast high in nutrients that should be limited, such as added sugars and sodium, tended to result in higher consumption throughout the day of nutrients that should be limited, with the same being true of beneficial nutrients (73). This suggests that the composition and quality of breakfast influences the composition and quality of subsequent dietary intake. One study reports that 362 fewer calories, on average, were consumed on days breakfast was not consumed, with no difference in energy intake at subsequent meals (75).

Breakfast Protein Intake on Obesity and Metabolic Parameters

While breakfast consumption has had inconsistent results pertaining to obesity prevalence, one aspect of breakfast that lends explanation is that of breakfast composition. Protein consumption at breakfast has been studied to further investigate these associations, with one study showing that consumption of high-protein breakfasts (35 grams) prevented fat mass gains over a twelve-week period in adolescents when compared to skipping breakfast (76). As whey and casein proteins affect postprandial blood glucose differently, Kung et al. showed through milk consumption at breakfast that both normal and high dairy protein concentrations (3.1% mass and 9.3% mass, respectively) reduced postprandial blood glucose concentrations in young adults when compared to a water control, with the high dairy protein concentration having a greater reduction than the normal dairy protein concentration (77). This demonstrates the potential benefit of high-protein consumption on improving glucose control. In another study with type 2 diabetic adults, high-whey protein breakfasts showed the lowest overall area under the curve (AUC) for postprandial plasma glucose and the highest overall AUC for postprandial plasma insulin compared to an equivalent protein breakfast but with various protein sources and a high-carbohydrate breakfast (78). Furthermore, the overall AUC for glucose after the breakfast, lunch, and dinner was lower in the high-whey protein breakfast when compared to the other breakfast types and led to weight loss and reductions in HbA1c (78). These results suggest that composition of breakfast protein can elicit different metabolic responses after breakfast and subsequent meals.

Breakfast Protein Intake on Satiety and Hunger

The effects of breakfast consumption and composition of protein at breakfast have been studied in the context of satiety and appetite control in children and adolescents. Breakfast consumption has been associated with a reduction in daily hunger and an increase in daily fullness when compared to skipping breakfast, with a stronger fullness response observed after consuming a high-protein breakfast (40%) compared to a normal-protein breakfast (15%) (79). A second study concluded with similar results, showing that high-protein breakfast consumption was associated with reductions in daily hunger when compared to breakfast skippers while also showing that high-protein breakfast consumption prevented fat mass gains and reduced daily intake when compared to breakfast skippers (76). However, these associations were not observed when comparing high-protein breakfasts to normal-protein breakfasts, suggesting that high protein consumption is needed to elicit a positive response for the beneficial effects observed. Coupled with this, Gaal et al. showed that protein intake at breakfast was lower than relative daily intake, with dietary quality increasing as daily protein intake increased (74). Given that skipping breakfast has been associated with detrimental snacking habits, one study showed that high-protein breakfast consumption was associated with reduced evening snacking of high-fat foods when compared to both skipping breakfast and consuming a normal-protein breakfast (15%) (79). Together, these studies propose that protein intake at breakfast is associated with increased satiety and appetite control throughout the day.

Breakfast Sugar Intake on Daily and Subsequent Intake

As aforementioned, sugar intake at breakfast has been associated with sugar intake throughout the day among Mexican children (73). This same study reported that this cohort of 3,760 children (4-13 years of age) had six breakfast dietary patterns; however, sugar-sweetened beverages were consumed amongst all patterns, with breakfast skippers having the lowest intake of several nutrients to limit, such as added sugar (73). Barr et al. reported that while breakfast consumers had higher dietary quality, they also had higher intake of sugars, with sugar intake increasing across dietary quality tertiles, which was attributed to increased consumption of products such as fruit and milk (71). In contrast, one study showed that breakfast contributed to higher consumption of carbohydrate and non-milk extrinsic sugars when compared to relative daily intakes (74). Another study found that consumption of a low-protein, high-carbohydrate breakfast is associated with higher subsequent energy intake at lunch and dinner when compared to consumption of a high-protein, low-carbohydrate breakfast (80). The associations of sugar consumption on adiposity and blood glucose could be contributing to the somewhat contradicting results seen in this area of breakfast research (81, 82).

National School Lunch and Breakfast Programs

In 2018, the National School Lunch Program (NSLP) served nearly 30 million children while the School Breakfast Program (SBP) served nearly 15 million children, with probability of participating in the SBP being higher in Hispanic children than non-Hispanic white counterparts (33, 83). Given that Hispanic households are more likely to be food insecure the NSLP serves as an instrument to ensure adequate nutrition to these low-income children. Literature has shown that NSLP participation increases odds of children having adequate food (84, 85), with one showing a 6% reduction in low household food security (85). Likewise, the SBP has shown to reduce the risk of marginal food insecurity (86). While the SBP has been associated with positive nutritional outcomes, such as increased fruit and vegetable intake in multi-ethnic, low-income children (87-89), other work has shown contrary results, suggesting the need for other improvements (90, 91).

Currently, there are no recommendations for breakfast in the *Dietary Guidelines for Americans, 2010* (92), and the current guidelines for the School Breakfast Program consist of only three requirements: one cup of fruit, one cup of dairy, and 7-10 oz. equivalents of grains (93). However, each of the requirements has one caveat, with fruit juice and flavored milk fulfilling the fruit and dairy requirements, and only 50% of grains must be whole-grain rich (93). The lack of recommendations and requirements in current policy coupled with the disparities that disproportionately affect Hispanic children warrants the need for updated guidelines that contain requirements for beneficial nutrient components such as protein and fiber.

Breakfast Skipping Prevalence

Though breakfast consumption has been strongly associated with positive outcomes pertaining to metabolic and anthropometric parameters and superior dietary intake and quality, the International Breakfast Research Initiative reports breakfast not being consumed daily for approximately one third to one half of older children (94). Furthermore, children and adolescents skip breakfast more than any other meal (95, 96), with one study showing higher prevalence in Hispanic youth (32%) compared to Caucasian youth (19%) (95). Primary reasons for skipping breakfast have included (1) lack of time, effort, and nutritional knowledge; (2) not feeling hungry; (3) financial constraints, lower household income, and greater socioeconomic disadvantage; (4) and not having access to appropriate breakfast foods (36, 52, 97). Literature shows that skipping meals is associated with more snacking occasions and lower dietary quality (i.e. lower fruit and vegetable intake and higher sodium, fat, and added sugar intake) (98, 99). Ramsay et al. showed breakfast skippers had greater energy intake from other meals and snacks, with snacks contributing to 40% of the daily energy intake and added sugar contributing to 25% of energy from snacks (100).

Food Insecurity on Breakfast Consumption

Skipping breakfast has been attributed to financial constraints and having limited access to appropriate breakfast foods, with food insecurity prevalence being higher in Hispanic households and associated with increased obesity prevalence in Hispanic children (34-36). In a study that explored parents', children's, and experts' perceptions about breakfast consumption in a disadvantaged community, though there may be high motivation to eat breakfast, experts note food availability and lack of opportunity and ability as primary barriers (36). Experts perceived more challenges than both mothers and children, though children also perceived lack of opportunity as a barrier in achieving healthy breakfast habits (36). On the other hand, the SBP serves to eliminate such barriers, providing breakfast to many food insecure children outside the home environment. In a study containing approximately one-half food-insecure children, SBP participation was only 31.2% of the time, 13% did not participate, and nearly 20% purchased breakfast from a corner store (101). While the SBP is easily accessible, many students are not using it and are instead either skipping breakfast or consuming foods for breakfast that are not as adequately nutritious as provided through the SBP. In adults, a recent study compared breakfast consumption among regular food pantry clients in rural communities and resulted in those who consumed breakfast having higher mean intakes of all nutrients while having lower prevalence of at-risk intakes, with exceptions to vitamin D, vitamin E, and magnesium (102). This demonstrates that many in disadvantaged populations are still able to meet dietary intake recommendations when breakfast is consumed. As other aspects of food insecurity, such as utilization and accessibility of foods for breakfast, could be influencing breakfast consumption or lack thereof in food-insecure populations, research in this area remains to be explored.

Summary

Majority of the literature supports breakfast consumption being associated with positive health outcomes relating to weight management and metabolic parameters. However, recent literature on breakfast consumption shows mixed results, particularly its association to adiposity. Composition and quality of breakfast have emerged as areas of research regarding dietary habits. Barriers such as food insecurity not only prevent breakfast consumption but also consumption of a healthy breakfast. With the SBP in place to aid in consumption of breakfast in these populations, research shows that eligible students may still not participate in the program. Furthermore, research shows the need for the SBP and NSLP to improve the requirements to provide more healthful foods to students. Given that Hispanic youth have higher prevalence of obesity and other comorbidities and are more likely to be food-insecure compared to other race/ethnicities in pediatric populations, research evaluating breakfast consumption and quality on health outcomes in low-income, Hispanic children is warranted.

Table 1. Literature Table for Literature Review			
Reference	Subjects	Methods	Results/Conclusions
Childhood Obesity and Associated Disease Prevalence			
Hales. NCHS Data Brief 2017; 2017(288).(1)	U.S. population 2-19 y/o M&F U.S.	• Report on most recent national estimates from 2015-2016 on obesity prevalence by sex, age, and race and Hispanic origin	• OB prevalence among youth was 18.5% • OB prevalence among Hispanic youth was highest at 25.8% compared to NHB (22.0%), NHW (14.1%), and NHA (11.0%)
Hales. JAMA 2018;319(16).(2)	N=16875 2-19 y/o M&F U.S.	• Cross-sectional survey • Analyzed trends in OB among US youth between 2007-08 and 2015-16 • OB was defined as a BMI at or above 95th percentile of sex-specific BMI-for-age	• OB prevalence was 16.8% in 07-08 and 18.5% in 15-16. • Unadjusted models showed no significant linear trends in prevalence of OB overall, by sex or age group. • OB prevalence among children 2-5 y/o showed quadratic trend decreasing from 10.1% to 8.4% in 11-12 and then increasing to 13.9% in 15-16. • Adjusted overall linear and quadratic trends for OB youth 2-19 y/o remained nonsignificant. • There were no overall significant trends among youth.
NIH. Obes Res 1998;2:51S-209S.(3)	U.S. population	• Evidence report	• ~97 million adults in U.S. OW/OB, raising risk of morbidity from HTN, dyslipidemia, type 2 diabetes, CHD, stroke, and others • Highlights obesity as a complex multifactorial chronic disease
CDC. Nat Diab Stat Report 2020.(4)	U.S. population	• Statistics report	• Type 1 diabetes prevalence among children and adolescents increased from 2002-2015 • Hispanic children and youth have the largest increases of type 1 diabetes from 2002-2010 • Type 2 diabetes prevalence increased from 2002-2015 in those 10-19 y/o • Again, incidence increased significantly more during 2002-2010 and 2011-2015 in Hispanics • In 2018, ~210,000 children and adolescents (< 20 y/o) have diabetes (~187,000 of those having type 1)
DeBoer. J Pediatr 2011;159(6).(5)	N=3693 12-19 y/o M&F U.S.	• NHANES 1999-2008 data • Evaluated ethnic and sex differences in MetS diagnosis and fasting insulin	• Females had higher insulin values than males • NHB and Hispanics had higher insulin than NHW • Those with MetS had higher insulin than those without • Difference between those with and without MetS was greater in NHB than NHW • NHB do not meet current criteria for MetS until reaching a more advanced degree of insulin resistance
Rosner. Hypertension 2013.(6)	N=3248 from NHANES III N=8388 from NHANES 1999-2008 8-17 y/o M&F	• NHANES data from 1988-1994 (III) & 1999-2008 • Analyze longitudinal trends in prevalence of elevated BP • Main outcome was elevated BP (systolic BP or diastolic BP ≥90th percentile or systolic BP/diastolic BP ≥120/80 mm Hg)	• Prevalence of elevated BP increased from NHANES III to 1999-2008 (boys 15.8% to 19.2%; girls 8.2% to 12.6%) • Waist circumference and sodium intake were independently associated with prevalence of elevated BP

Table 1 (continued)

	U.S.		
Jackson. MMWR July 2018;18(9).(7)	N=U.S. youths 12-19 y/o M&F U.S.	• Morbidity and Mortality Weekly Report (CDC) • Used new 2017 American Academy of Pediatrics Clinical Practice Guideline	• 1 in 25 of 12-19 y/o have HTN • 1 in 10 have elevated BP • High BP more common in youth with OB
Kit. JAMA Pediatr 2015;169(3).(8)	N=1482 8-17 y/o M&F U.S.	• Cross-sectional • Describe prevalence of and trends in dyslipidemia and adverse BP among U.S. children and adolescents • NHANES survey data	• HTN prevalence higher in Hispanic children compared to NHW • ~ 1 in 5 children and adolescents aged 8-17 y/o had adverse lipid concentration of TC, HDL, or non-HDL and slightly more than 1 in 10 had borderline high or high BP • Hispanic children and adolescents had highest prevalence of high total cholesterol and non-HDL cholesterol and low HDL cholesterol compared to NHW, NHB, and Asian populations
Mayer-Davis. Metab Sydnr Relat Disord 2009;7(2).(9)	N=1293 3-17 y/o M&F U.S.	• Included youths who participated in SEARCH for Diabetes in Youth study with diabetes diagnosed < 20 years, with current age > 10 years (max 22 years) • CFA was performed to evaluate CVD risk factors	• Three correlated factors identified were obesity, lipids, and BP • Concept of MetS provides useful clinical descriptives but does not capture single target for research among youth with diabetes
Rodriguez. J Pediatr 2010;157(2).(10)	N=3691 3-17 y/o M&F U.S.	• Determine correlates of elevated BP in youth with diabetes • Used SEARCH data • Elevated BP = greater than or equal to 95 sys/dia • In youth with elevated BP, awareness defined as self-report of prior diagnosis	• Prevalence of elevated BP in T1DM 5.9% • Minority ethnic groups, obese adolescents, and youth with poor glycemic control disproportionately affected • 23.7% of adolescents with T2DM had elevated BP
Nguyen.NCHS Data Brief 2015;2015(228).(11)	U.S. population 6-19 y/o	• Report that provides estimates from NHANES (from 2011-2014) on the prevalence of total cholesterol, HDL, and non-HDL among children and adolescents	• 7.4% of children and adolescents had high total cholesterol (higher in OB than OW and NW) • 13.4% of children and adolescents had low HDL (Hispanics had highest prevalence, 15.6%) • Prevalence of low HDL higher in OB than OW and NW
Breslin. Pediatrics 2012;129(5).(12)	N=128 10-16 y/o M&F U.S.	• Cross-sectional • Investigate alterations in monocytes and cytokines among healthy weight, OW, and OB Mexican American children	• OW/OB children had elevated TG and reduced HDL compared to healthy weight
Cook. Arch Pediatr Adolesc Med 2003;157(8).(13)	N=2430 12-19 y/o M&F U.S.	• Cross-sectional • Data from NHANES III • Measured prevalence and distribution of MetS among US adolescents, using National Cholesterol Education Program definition modified for age	• MetS prevalence 4.2% • MetS prevalence 28.7% in OW adolescents compared with 6.8% of at-risk adolescents and 0.1% of those with a BMI below 85th percentile

Table 1 (continued)

Cruz. J Clin Endocrinol Metab 2004;89(1).(14)	N=126 8-13 y/o M&F U.S.	• Cross-sectional • OW Hispanic children with family history of T2DM • MetS defined as having at least three: abdominal obesity, low HDL, hypertriglyceridemia, HTN, and/or impaired glucose tolerance	• Prevalence of zero, one, two, or three risks of MetS were 9, 22, 38, and 30%, respectively • Insulin sensitivity was positively related to HDL and negatively related to TG and BP • Insulin sensitivity decreased as number of risks of MetS increased
de Ferranti. Circulation 2004;110(16).(15)	N=1960 12-19 y/o M&F U.S.	• Cross-sectional • NHANES III survey • Defined MetS as having at leas three: TG >= 100, HDL < 50, except in boy 15-19 y/o (<45), glucose >= 110, WC > 75th percentile for age and gender, and sys BP > 90th percentile for gender, age, and height	• Two-thirds of children had at least 1 risk • Nearly 1 in 10 had MetS • Mexican-Americans, followed by NHW had greater prevalence of MetS compared to NHB • Nearly one-third of OW/OB had MetS
Weiss. N Engl J Med 2004;350(23).(16)	N=490 4-20 y/o M&F U.S.	• Cross-sectional • Glucose-tolerance test to 439 OB, 31 OW, and 20 nonobese children and adolescents • MetS risk factors were collected	• Prevalence of MetS increased with severity of OB and reached 50% in severely OB • Half-unit increase of BMI z-score was associated with an increase in the risk of MetS among OW and OB subjects as was each unit of increase in insulin resistance • Prevalence of MetS increased with increasing insulin resistance for trend
Alberti. Lancet 2005;366(9491).(17)	N/A	• Paper reviewing MetS	• Highlights importance of WC/central obesity being a component of MetS
Ford. Diabetes Care 2005;28(4).(18)	N=1366 12-17 y/o M&F U.S.	• Cross-sectional • NHANES 1999-2000 • Modification of MetS proposed by the Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults was used • Measured CRP	• Mean and median concentrations of CRP were higher among participants who had MetS than those who did not • Of five components, only abdominal obesity was independently associated with concentrations of CRP
Deboer. Expert Rec Endocrinol Metab 2011;6(2).(19)	N/A	• Paper highlighting implications on assessing risk and target interventions on ethnicity and obesity parameters contributing to MetS	• Hispanic children have higher rate of WC than other groups but similar rates for other risks as NHW
Morrison. J Pediatr 2008; 152(2).(20)	LRC N=814 5-19 y/o PFS N=814 30-48 y/o	• Retrospective follow-up study • Data from NHLBI Lipid Research Clinics Princeton Prevalence Study and the Princeton Follow-up Study • BMI was used as OB measure in childhood because WC not measured at the LRC • Adult T2DM status of participants and their parents obtained by self-report or fasting glucose >= 126	• Pediatric MetS, parental diabetes, age at follow-up, and change in age-specific BMI percentile were predictors of MetS in adulthood • Pediatric MetS, age at follow-up, black race, and parental diabetes were predictors of T2DM

Table 1 (continued)

Clark. Nat Rev Cardiol 2009;6(11).(21)	N/A	• Paper reviewing SES and CVD risks and implications for care	• One key point is that it highlights low SES is inversely associated with CVD, which can develop into MetS • Thus, implies that low SES can have a role in development of MetS
Puolakka. Diabetes Care 2016;39(12).(22)	N=2250 3-18 y/o M&F Finland	• Longitudinal study • Cardiovascular Risk in Young Finns Study cohort • Followed for 31 years • SES characterized as reported annual income of family classified on an 8-point scale	• Each 1-unit increase in family SES in childhood decreased risk for MetS in adulthood • Lower SES in childhood predicted large WC and high TG
Risk Factors for Childhood Obesity			
Kapral. Pediatr Obes 2018;13(6).(23)	N=10,186 Early school-aged children (kindergarten-second grade) M&F U.S.	• Linear and logistic regression to evaluate children in the Early Childhood Longitudinal Study-Kindergarten Cohort 2011 for relationships between BW and later OB and change in BMI z-score from kindergarten to second grade.	• Compared to NBW, HBW children and large-for-gestational-age (LGA) preterm children had significantly greater BMI z-scores from kindergarten to second grade • Term children born HBW had higher odds of OB by kindergarten • Among preterm children, odds of OB was higher among LGA children starting in first grade • Compared to NBW children, HBW children had greater change in BMI z-score between kindergarten and first grade • HBW term and LGA preterm children had increased adjusted odds of obesity in school-age compared to their NBW counterparts
Seyednasrollah. Circ Cardiovasc Genet 2017;10(3).(24)	N=2262 3-18 y/o + 31 years later M&F Finland	• Longitudinal • Participants from the Cardiovascular Risk in Young Finns Study • Data were divided into training and validation • Effect of genetic risk factors weighted as genetic risk score of 97 SNPs or subset of 19 most significant SNPs using boosting machine learning technique. • WGRS97 and WGRS19 were validated using external data from BogalU.S. Heart Study.	• WGRS19 improved accuracy of predicting adulthood obesity in training and validation data. • WGRS97 improved the accuracy in training <u>but not</u> in validation data. • Higher WGRS19 associated with higher BMI at 9 years and WGRS97 at 6 years. • Replication in BHS confirmed findings that WGRS19 and WGRS97 are associated with BMI. • WGRS19 improves prediction of adulthood OB, with predictive accuracy highest among young children (3-6 y/o). • However, among older children (9-18 y/o), the risk can be identified using childhood clinical factors. • Model is helpful in screening children with high risk of developing obesity.
Garmy. J Pediatr Nurs 2-18;39:e1-e5.(25)	N=1260 10 y/o M&F Sweden	• Cross-sectional self-report survey of children in grade 4 (mean age, 10.1) living in southern Sweden (49.1% boys). • The heights and weights of 1097 (87.1%) of the children were recorded. •	• The median length of self-reported sleep on weeknights was 9.5 h. • Approximately 40% of the children reported receiving < 9 h of sleep. • The median bedtime was 9 PM (21:00). On weekends, the median bedtime was 1 h later, and they delayed getting up by 1.5 h. • The median time spent watching TV and using a computer was 1 h each. • The prevalence of being overweight (including obesity) was 18%. • Insufficient sleep (< 9 h) was associated with being overweight, watching TV, or using a computer for two or more hours each day, difficulty falling asleep, and being tired at school. •

Table 1 (continued)

Laguna. J Paediatr Child Health 2013;49(11).(26)	N=487 children 9 y/o M&F Spanish children	• Cross-sectional • A sample of children from the European Youth Heart Study participated. • The variables measured were anthropometric characteristics (height, weight and body mass index), and PA was measured during 6 consecutive days using a GT1M accelerometer. •	• Nine-year-old normal-weight children achieved significantly (P < 0.05) more MVPA on weekdays than 9-year-old overweight/obesity children. • During weekend days, all sample achieved significant more MVPA (P < 0.01) and significant more VPA (P < 0.05) than during weekdays. • Few children (37.5% of 9-year-old normal-weight and 34.0% of 9-year-old overweight/obese) met the current health-related recommendations of 60 min of MVPA daily. •
LeBlanc. PLoS One 2015;10(6).(27)	N=5,844 9-11 y/o M&F Several countries	• The sample included 45.6% boys with a mean age of 10.4 years from study sites in Australia, Brazil, Canada, China, Colombia, Finland, India, Kenya, Portugal, South Africa, the United Kingdom, and the United States. • Child- and parent-reported behavioral, household, and neighborhood characteristics and directly measured anthropometric and accelerometer data were obtained. • Twenty-one potential correlates of sedentary time (SED) and screen time (ST) were examined using multilevel models	• Children averaged 8.6 hours of daily SED, and 54.2% of children failed to meet ST guidelines. • In all study sites, boys reported higher ST, were less likely to meet ST guidelines, and had higher BMI z-scores than girls. • In 9 of 12 sites, girls engaged in significantly more SED than boys. • Common correlates of higher SED and ST included poor weight status, not meeting physical activity guidelines, and having a TV or a computer in the bedroom.
Wang. Child Obes 2017;13(3).(28)	N=1234 2mo.-6th grade M&F U.S.	• U.S. longitudinal data collected from children were analyzed using logistic regression models and generalized estimating equation. • Child height and weight were measured six times at ages of 24 months, 24 months, 36 months, 54 months, grade 1, grade 3, and grade 6.	• Nonsmoking, white, married mothers with both parents in the household, and with income above the poverty line, were more likely to breastfeed at 1 month of age their babies. • OB rate of children increased with age from 24 months to grade 6. • Logistic regression showed that breastfeeding at month 1 was associated with 53% decreased risks for childhood OB by 36% from aged 24 months through grade 6. • Regarding breastfeeding duration, more than 6 months (vs. never) was associated with a decreased risk for childhood OB by 42%. • Breastfeeding at 1 month and more than 6 months reduced the risk of childhood obesity.
Taveras. JAMA Pediatr 2013;167(8).(29)	N=1116 mother-child dyads U.S.	• Retrospective study • Examined extent to which racial/ethnic disparities in adiposity and OW during pregnancy, infancy, feeding practices, etc. • Pregnancy exposures: mother smoking and having prenatal depression • Infancy exposures: rapid weight gain, nonexclusive breastfeeding, consuming solid foods before 4 months of age • Early childhood exposures: low sleep duration, fast food intake, and TV in bedroom	• All exposures listed were associated with higher childhood obesity prevalence in Hispanic children compared to NHW and NHB children

Table 1 (continued)

		• Mother's report of child's race/ethnicity • OW/OB defined as BMI >= 85th percentile at 7 years	
Chung. Obes Rev 2016;17(3).(30)	N=30 studies 2-18 y/o M&F	• Systematic review • Eligible studies reported overweight and obesity prevalence in children and/or adolescents (2–18 years), for at least two time points since 1990, stratified by SEP. • Socioeconomic differences in trends in child and adolescent overweight and obesity over time were analyzed. •	• Differences in trends between socio-economic position (SEP) groups were observed across a majority of studies. • Over half the studies indicated increasing prevalence among low SEP children and adolescents compared to a third of studies among children and adolescents with a high SEP. • Around half the studies indicated widening socioeconomic inequalities in overweight and obesity. • Since 2000 a majority of studies demonstrated no change or a decrease in prevalence among both high and low SEP groups. However around 40% of studies indicated widening of socioeconomic inequalities post-2000.
Jones. Biodemography Soc Biol 2018;64(1).(31)	N=12,686 14-22 y/o in 1979	• Longitudinal • The National Longitudinal Survey of Youth 1979 (NLSY79) is a nationally representative sample of 12,686 young men and women who were 14-22 years old	• Results from linear mixed-effects models indicate that maternal educational gains and maternal employment transitions significantly increased their child's body mass index (BMI). • This finding suggests that mothers who work may have less time to devote to monitoring their child's food intake and physical activity, which places their children at higher risks of becoming overweight or obese over time. • Conversely, father's work transitions and educational gains contribute to decreases in child's BMI. • Thus, work instability and increasing educational attainment for the traditional breadwinner of the household corresponds to better child weight outcomes.
Moraeus. Int J Obes (Lond) 2012;36(7).(32)	N=3636 7-9 y/o M&F Sweden	• Cross-sectional • Overweight and obesity (International Obesity Task Force (IOTF)) data were analyzed in relation to lifestyle factors, parental weight, education and breast-feeding.	• Urbanization level and parental characteristics (weight status and education) were related to risk of overweight. • Overall less favorable lifestyle characteristics were observed in rural areas and for children of low/medium educated mothers. • Boys had greater risk of obesity in semi-urban and rural areas. • For children overweight, the living area effect was attenuated in multivariate analysis, while there was an association with origin of parents, high parental weight and medium maternal education. • Parental weight status was associated with obesity in both girls and boys. • Individual and societal factors influence children's weight status, and parental weight status is a strong determinant.
Food Insecurity on Obesity Risk and Diet			
Coleman-Jensen. USDA Econ Res Serv 2019.(33)	U.S. population	• Report on household food security in the U.S. in 2018	• Prevalence of food insecure households was 11.1% • 7.1% of households had food insecure children, resulting in inadequate amounts of nutritious foods • Rates of food insecurity were higher than the national average for Hispanic households at 16.2%

Table 1 (continued)

Papas. J Immigr Minor Health 2016;18(5).(34)	N=74 Mother-child dyads U.S.	• Cross-sectional • USDA 18-item Household Food Security Survey was used to determine food security status • Investigated association between food insecurity and OB among low-income, Hispanic dyads	• 74% of households were food insecure and one-third of children were OB • FI increased odds of childhood OB; stronger associations in households where mothers were OW/OB compared to NW
Potochnick. J Adolesc Health 2019;64(5).(35)	N=1362 8-16 y/o M&F Latino youth U.S.	• Cross-sectional • Hispanic Community Children's Health Study of Latino Youth • Examined correlates of household and child food insecurity and very low food security • Assessed four sets of risk/protective factors: child demographic, acculturation, socioeconomic, and family/social support • Also examined BMI, diet quality, depression, and anxiety	• Found high rates of food insecurity: Hispanic/Latino youth 42% • 10% lived in very low food secure households • Hispanic/Latino youth in food insecure households experienced greater acculturative and economic stress and weakened family support systems compared to food secure peers
van Kleef. Appetite 2016;107:372-82.(36)	N=32 mothers N=44 children Netherlands	• Focus groups with mothers and children • Interviews with experts using interview guides that were developed based on the motivation, opportunity, and ability consumer psychology model	• Themes emerged from focus groups: generally high motivation to have breakfast, improved performance at school is key motivator, limited time hinders breakfast, and lack of nutritional knowledge about high quality breakfast • Experts mentioned lack of time, financial constraints, and environmental issues (food availability) as barriers to consuming healthy breakfast • Experts perceived more problems and challenges in achieving healthy breakfast habits than did mothers and children • Lack of opportunity (according to children and experts) and ability (according to experts) were identified, even when motivation was present
Darling. Health Psychol 2017;22(5).(37)	N=98 Young adults M&F	• Retrospective study • Study examined differences in physical health and mental health outcomes in young adults with and without a history of food insecurity	• Those with a history of FI had higher average levels of BMI, WtH ratio, depressive symptoms, stress, and eating disorders than individuals with no FI history • No differences observed in anxiety • Interventions should target decreasing negative mental health outcomes and risk for OW among young adults who have experienced FI
Seligman. N Engl J Med 2010;363(1).(38)	N/A	• Paper on hunger and socioeconomic disparities in chronic disease	• Makes key point that FI has been associated with many negative health outcomes, including OB, but FI has also been associated with dietary intake • FI has been associated with increased consumption of inexpensive energy-dense foods high in carbohydrates and fat
Fram. J Nutr 2015;145(3).(39)	N=3605 4th and 5th graders M&F U.S.	• Children whose schools were in the Network for a Healthy California-Children's PowerPlay! Campaign	• FI prevalence 60% • Greater levels of FI were associated with higher consumption of energy, fat, sugar, and fiber and lower consumption of vegetables

Table 1 (continued)

		• 24-h diary assisted recalls and surveys including items from Child Food Security Assessment and questions about PA	
Landry. Nutrients 2019;11(7).(40)	N=598 Avg. age 9.2 y/o M&F U.S.	• Cross-sectional • Examined self-reported FI and dietary quality among low-income children • Two 24-h dietary recalls • Questionnaire including adapted version of the 5-item Child Food Security Assessment • Dietary quality assessed using HEI-2015	• FI was associated with lower HEI-2015 total scores • Compared to FS children, FI children had lower greens/beans, seafood/plant protein, and added sugar component scores
Belachew. PLoS One 2013;8(3).(41)	N=2084 Baseline age 13-17 y/o M&F Ethiopia	• Longitudinal study • Five-year follow-up • FI measured using validated scales • Dietary practices measured using dietary diversity score, food variety score, and frequency of consuming animal source food	• FI adolescents had low dietary diversity score, low mean food variety score, and low frequency of animal source food consumption • FI and rural residence were negatively associated with likelihood of having diverse diet and frequency of consuming animal source foods while at a high household income tertile was positively associated • FI negatively associated with food variety score while residence in semi-urban areas, urban areas, and high household income were positively associated
Nackers. J Nutr Educ Behav 2013;45(6).(42)	N=41 U.S.	• Cross-sectional • Parent/caregiver had to have at least one child 2-13 y/o and reside in a low-income area with limited food access • Completed home food inventory and a validated measure assessing household FS	• Compared to FS participants, marginal or low/very low food-secure caregivers reported significantly more OB-promoting foods in home, notably microwavable or quick-cook frozen foods, and greater access to less healthful foods in the kitchen

Reference	Subjects	Methods	Skipping Definition	Breakfast Evaluation	Prevalence of Skipping	Results/Conclusions
Breakfast Consumption on Obesity and Metabolic Parameters						
Monzani. Nutrients 2019;11(2).(43)	N=489 6.7-13 y/o M&F Italy	• Systematic review • Breakfast consumption: yes/no	Response is "No"	Varied	Varied	• In schoolchildren aged 10.1-13 y/o, no breakfast consumption was higher in those with MetS.
Horikawa. Prev Med 2011;53(4-5).(44)	N=19 studies N=93108 total participants Several countries	• Meta-analysis • Searched for observational studies with cross-sectional design • Examine the relationship between breakfast consumption frequency and OW/OB prevalence	Varied	Varied	Varied	• Pooled OR for OW/OB for lowest vs. highest breakfast frequency was 1.75 • Between-study heterogeneity in the association was highly significant • Study suggests positive association between skipping breakfast and OW/OB
Archero. Nutrients 2018;10(9).(45)	N=669 6-16 y/o M&F Italy	• Cross-sectional • Self-reported questionnaires compiled by the children during	Breakfast skipping (yes/no)	Italian version KIDMED index, a questionnaire	14.8% in primary school children	• OW/OB skipped breakfast more frequently than NW (chi-squared) • Increased risk for OW/OB in non-Italian breakfast skippers.

Table 1 (continued)

		• school-time in the presence of teachers and medical staff • Measured weight and height		of dichotomous items	21.9% in secondary school children	
Fayet-Moore. Nutrients 2016;8(8).(46)	N=4487 2-16 y/o M&F Australia	• Cross-sectional • Computer-assisted interview based on 24-h recall methodology over two days from participants or caregivers • Measured height and weight	No energy consumption during breakfast on 2 recall days	24-h recall methodology	4% skipped	• Higher prevalence for OW/OB in skippers than consumers
Gotthelf. Arch Argent Pediatr 2017;115(5).(47)	N=2083 9-13 y/o M&F Argentina	• Cross-sectional • Self-reported questionnaires compiled by children and parents • Measured weight and height	Breakfast habit: eating breakfast on the day of the survey (yes/no); frequency: always (6-7 days/wk), sometimes (2-5 days/wk), and never (0-1 day/wk)	FFQ	64.1% of students from peri-urban schools and 46.1% of students from urban schools	• Among breakfast skippers, 40.7% of girls and 54.7% of boys were OW/OB. • Higher probability of skipping breakfast was associated with OB prevalence.
Ho. Res Dev Disabil 2015;43-44:179-88.(48)	N=2401 Elementary school children M&F Taiwan	• Elementary School Children's Nutrition and Health Survey in Taiwan (NAHSIT) • Self-report questionnaire • Measured height, weight, WC and BP • Venous blood sample was collected for lipid profile and glucose metabolism	Breakfast consumption was assessed using question "How often do you eat breakfast in a week?" Answer could range from 0-7 times. The frequency was classified into three groups: 0-4, 5-6, and 7 times per week	24-h recall; FFQ US-YHEI modified to YHEI-Taiwan: indicator of diet quality	5.4%, 0-4 times/wk 5.9%, 5-6 times/wk 88.7% 7 times/wk	• Those who consumed breakfast daily had lower BMI and WC • Regular breakfast consumption was associated with higher diet quality. • Daily consumption associated with lower risk of high blood pressure and MetS.
Nilsen. Scand J Public Health 2017;45(8).(49)	N=2620 7-9 y/o M&F Sweden	• Cross-sectional • Proxy questionnaire filled out by the parents/guardians • Measured height and weight	No. of breakfasts eaten over the week: - every day (7 days) - most days (4-6 days)	FFQ	4.6% skipped	• Positive association between OW/OB and not having breakfast every day • Breakfast skipping, diet soft drinks and low-fat milk consumption were more frequent among OW/OB children. • More longitudinal studies are needed to determine caU.S.l relationships.

Table 1 (continued)

			- some days (1-3 days) never (0 days)			
O'Neil. AIMS Public Health 2015;2(3).(50)	N=14200 2-18 y/o M&F U.S.	• Cross-sectional • Self-reported questionnaires (parent-reported for 2-5 y/o; parental assist 6-11 y/o; 12+ self-reported) • Measured weight and height	24-h dietary recall: no breakfast or 11 possible breakfast patterns	24-h dietary recall interviews using multiple-pass method	18.7% skipped	• BMI z-scores were lower among consumers of five breakfast patterns compared to breakfast skippers - Grain/lower fat milk/sweets/fruit juice - Pre-sweetened ready-to-eat cereal/whole milk - Soft drinks/fruit juice/grain/potatoes - Ready-to-eat cereal/whole milk • Cooked cereal/milk/fruit juice
Smetanina. BMC Public Health 2015;15:1001.(51)	N=3990 7-17 y/o M&F Lithuania	• Cross-sectional • Self-reported questionnaires (parents of 7-9 y/o completed questionnaire at home; older filled in themselves at school) • Measured weight and height	Frequency: everyday (including every day and 4-6 times per week), 1-3 times, and never	Modified WHO questionnaires & FFQ	Never eating: 6.2% in UW 6.5% NW 9.6% in OW/OB	• Skippers had higher prevalence of OW/OB than NW.
Smith. Aust N Z J Public Health 2017;41(6).(52)	N=1592 2-17 y/o M&F Australia	• Cross-sectional • Computer-assisted interview based on 24-h recall methodology - 2-5 y/o completed by adult - 6-8 y/o adult interviewed with help from child - 9-11 y/o interviewed directly with assistance from adult - 12-17 y/o interviewed directly, with adult remaining in room for 12-14 y/o • Measured weight and height	No eating occasion defined as "breakfast" in the 24-h recall or the energy intake for the occasion was <210 kJ	24-h recall methodology	11.8% boys and 14.8% girls skipped on one day 1.4% boys and 3.8% girls skipped on both days	• Skipping breakfast was associated with being female, being older, being UW, OW, or OB – among others. • Odds of skipping breakfast were higher with increasing BMI category • Skipping breakfast was common but few consistently skipped. • Interventions to increase breakfast consumption should target adolescents, particularly girls, and low SEP households.
Tee. Asia Pac J Clin Nutr 2018;27(2).(53)	N=8332 6-17 y/o M&F	• Cross-sectional • Self-administered questionnaire with	Skippers (0-2 days/week), irregular eaters	FFQ	9.3% in primary	• Compared to regular eaters, the risk of being OW/OB was higher in 6-12 y/o boys

Table 1 (continued)

	Malaysia	assistance to children aged 10 y/o and above; proxy questionnaire administered to the parent for children aged 6-9 y/o • Measured weight and height	(3-4 days/week), and regular eaters (ate breakfast at least 5 days/week)		school children 15.9% in secondary school children	who skipped breakfast, in 6-12 y/o girls and in 12-17 y/o girls. • Regular breakfast consumption was associated with a healthier body weight status and is a dietary behavior that should be encouraged.
Zakrzewski. Int J Obes Suppl 2015;5(Suppl 2).(54)	N=6841 9-11 y/o M&F Several countries	• Cross-sectional • Self-reported questionnaires • Measured height, weight, and BF%	Three-category definition: 0-2 days/wk (rare), 3-5 days/wk (occasional), and 6-7 days/wk (frequent) Two-category definition: 0-6 days/week (less than daily) and 7 days/wk (daily)	FFQ	6.3% rarely 27.7% less than daily	• Frequent consumption associated with lower BMI-z scores and BF% compared with occasional and rare. • Associations were not consistent across all 12 countries. • Further research required to understand global differences in these observed associations.
Cho. J Am Coll Nutr 2003;22(4).(55)	N=16452 18+ y/o M&F U.S.	• Data from NHANES III were analyzed for breakfast type, total daily energy intake, and BMI • The analyzed breakfast categories were "Skippers," "Meat/eggs," "Ready-to-eat cereal (RTEC)," "Cooked cereal," "Breads," "Quick Breads," "Fruits/vegetables," "Dairy," "Fats/sweets," and "Beverages." • ANCOVA used to estimate adjusted mean BMI and energy intake as dependent variables • Covariates included age, gender, race, smoking, alcohol intake, physical activity, and poverty index ratio	Breakfast in NHANES III defined as any food/beverage consumed in a meal occasion named by respondent as "breakfast" or "desayuno". Subjects that took no food/beverage at breakfast, excluding water, were categorized as breakfast skippers.	Foods consumed at breakfast were categorized from a modified classification system based on the USDA food-coding scheme.	20.05% skipped	• Subjects who ate RTEC, cooked cereal, or quick breads for breakfast had significantly lower BMI compared to skippers and meat/egg eaters. • Breakfast skippers and fruit/vegetable eaters had the lowest daily energy intake. • The meat/eggs eaters had the highest daily energy intake and one of the highest BMIs. • Evidence that skipping is not an effective way to manage weight

Table 1 (continued)

Van Lippevelde. PLoS One 2013;8(11).(56)	N=6374 10-12 y/o M&F Several European countries	• Cross-sectional • Self-reported by children • Measured height and weight	Breakfast frequency per week calculated by adding up breakfasts usually had on school days (0-5) and weekends (0-2)	FFQ	Not reported	• Family breakfast frequency was negatively associated with BMI z-score. • Permissiveness concerning skipping breakfast and negotiating about breakfast were positively associated with the BMI-z-score. • Children's breakfast consumption was found to be a mediator of the two associations. • Future breakfast promotion and obesity prevention interventions should focus on family-related factors including the physical home environment and parenting practices.
Shafiee. J Pediatr (Rio J) 2013;89(6).(57)	N=5625 10-18 y/o M&F Iran	• The third survey of the national school-based surveillance system (CASPIAN-III) • Parent-report questionnaires • Measured weight, height, WC, and BP • Venous blood sample was collected for lipid profile and glucose metabolism	Three groups: • regular eater (6-7 days/wk) • often eater (3-5 days/wk) seldom eater (0-2 days/wk)	Likert scale questionnaire	47.3%, regular 23.7% often 29.0%, seldom	• Skippers had higher triglycerides, LDL-cholesterol and lower HDL-cholesterol. • Skipping also had increased risk of MetS.
Smith. Am J Clin Nutr 2010;92(6).(58)	Children: N=6559 Adult: N=2184 Child: 9-15 y/o Adult: 26-36 y/o M&F Australia	• Longitudinal study • National children sample from 1985 reported breakfast consumption • Follow-up in 2004-06, 2184 participants (26-36 y/o) completed meal-frequency chart for previous day • Four categories: skipped only in neither child/adulthood, skipped only in childhood, skipped only in adulthood, and skipped both child/adulthood	Child: "Do you usually eat something before school?" (yes/no) Adult: Defined as not eating a snack, small meal, or large meal between 0600 and 0900.	Child: survey question Adult: FFQ	14.2% skipped	• Skipped both child/adulthood: larger WC and higher fasting insulin, total cholesterol, and LDL cholesterol – compared to those who ate breakfast at both time points • Skipping breakfast over long period of time may have detrimental effects on cardiometabolic health

Table 1 (continued)

Deshmukh-Taskar. Public Health Nutr 2013;16(11).(59)	N=5316 20-39 y/o M&F U.S.	• Cross-sectional • Examined breakfast skipping and breakfast type on OW/OB, abdominal OB, other cardiometabolic risks, and MetS	Three groups: • skippers • RTEC • other breakfast consumers	24-h dietary recall	23.8% skipped	• Relative to BS, RTEC consumers were 31%, 39%, 37%, 28%, 23%, 40% and 42% less likely to be OW/OB or have abdominal obesity, elevated blood pressure, elevated total cholesterol, elevated LDL, reduced HDL or insulin, respectively.
Monzani. Clin Endocrinol (Oxf) 2014;81(1).(60)	N=489 6-13 y/o M&F Italy	• Population-based, cross-sectional study • Weight, height, WC, BP, lab parameters, parental information, lifestyle and dietary habits were collected • Dietary only available for subsample of 353 children	Breakfast consumption (yes/no)	Questionnaire	35.7% in MetS 9.9% in non-MetS	• MetS prevalence was 9.8% • In 10-13 y/o, the presence of parental history of OB, habits of not walking or cycling to school, long screen time, and no breakfast consumption were higher in children with MetS than those without
Osawa. Bull Tokyo Dent Coll 2015;56(4).(61)	N=689 10-13 y/o M&F Japan	• Cross-sectional study • Self-report questionnaire • Measured height, weight, WC, and BP • Venous blood sample was collected for lipid profile and glucose metabolism	"Do you have breakfast every day?" (yes, alone/yes, with family/seldom/no)	FFQ designed by members of the Ichikawa Dental Association	13.3% in MetS/high risk MetS 6.5% in non-MetS	• Not eating breakfast was associated significantly with MetS or high risk MetS.
Inconsistent Associations of Breakfast Consumption on Health Outcomes						
Fayet-Moore. Nutrients 2016;8(8).(46)	N=4487 2-16 y/o M&F Australia	• Cross-sectional • Computer-assisted interview based on 24-h recall methodology over two days from participants or caregivers • Measured height and weight	No energy consumption during breakfast on 2 recall days	24-h recall methodology	4% skipped	• Higher prevalence for OW/OB in skippers than consumers
Ho. Res Dev Disabil 2015;43-44:179-88.(48)	N=2401 Elementary school children M&F Taiwan	• Elementary School Children's Nutrition and Health Survey in Taiwan (NAHSIT) • Self-report questionnaire • Measured height, weight, WC and BP	Breakfast consumption was assessed using question "How often do you eat breakfast in a week?" Answer could range from 0-7 times. The	24-h recall; FFQ US-YHEI modified to YHEI-Taiwan: indicator of diet quality	5.4%, 0-4 times/wk 5.9%, 5-6 times/wk 88.7% 7 times/wk	• Those who consumed breakfast daily had lower BMI and WC • Regular breakfast consumption was associated with higher diet quality. • Daily consumption associated with lower risk of high blood pressure and MetS.

Table 1 (continued)

		• Venous blood sample was collected for lipid profile and glucose metabolism	frequency was classified into three groups: 0-4, 5-6, and 7 times per week			
Lepicard. J Hum Nutr Diet 2017;30(2).(62)	N=529 9-11 y/o M&F France	• Cross-sectional, observational • Total nutrient intake, mean adequacy ratio, energy density, and solid energy density calculated from breakfast food and fluid nutritional composition • Each breakfast item categorized into 15 solid and liquid food categories	Not having consumed no food or fluid for breakfast	1-day food diary	9.8% skipped	• Breakfast provided 22.9% energy intake and 24.7% of mean adequacy ratio of 23 key nutrients. • Four breakfast patterns identified: (1) sweets (40%); (2) traditional French (27.2%); (3) RTEC + milk (18.1%); and (4) dairy and juice (9.5%). • Nutritionally, the RTEC + milk breakfast was most advantageous; flavored milk was the most frequently consumed food (50.5%) and the major component of the traditional French breakfast
Deshmukh-Taskar. J Am Diet Assoc 2010;110(6).(63)	N=9659 9-18 y/o M&F U.S.	• Cross-sectional • Self-reported 24-hour recall over 2 days (with adult assistance for up to 11 y/o) • Measured weight, height, and wc	Those who consumed no food or beverages, excluding water, at breakfast	Two 24-hour recalls	20% children 31.5% adolescents	• Skippers had higher BMI z-scores and wc than ready-to-eat cereal and other breakfast consumers. • Increased obesity in skippers than ready-to-eat cereal consumers.
Nicklas. J Sch Health 2017;87(9).(64)	N=20329 2-18 y/o M&F U.S.	• Individual usual intakes were calculated from 24-h dietary recalls from NHANES 2001-2012 • IUI of > 0.25 cup eq. of flavored dairy milk defined consumers	N/A	N/A	N/A	• FM consumers consumed more milk • Consumers aged 2-3 years had higher added sugar intake • Consumers aged 2-3 and 9-13 years had higher SFA intake • Consumers aged 14-18 years had higher percent energy from SFA • Consumers had lower percentage of children meeting AI for fiber and a higher percentage meeting the EAR for calcium • Consumers aged 9-13 years had higher percentage of children meeting the EAR for magnesium
Coulthard. Br J Nutr 2017;118(4).(65)	N=1686 4-18 y/o M&F UK	• Cross-sectional • Four-day food diary to be completed by children, or their parent for those aged 11 y/o and under	Those consuming breakfast every diary day, those consuming breakfast on at least one but not all diary days, and	4-day food diary	19.9% girls 14.5% boys	• No differences in weight status by breakfast eating habits. • Overall nutritional profile of the children in terms of fiber and micronutrient intake was superior in frequent breakfast eaters (micro: folate, calcium, iron, and iodine).

Table 1 (continued)

		• Measured weight and height	those not consuming breakfast on any diary day			
Fayet-Moore. Nutrients 2017;9(10).(66)	N=2812 2-18 y/o M&F Australia	• Cross-sectional • Face-to-face interviews • Measured weight and height	No breakfast during the 24 hours prior to interview day	24-h recall methodology	9% skipped	• No associations between anthropometric measures and breakfast or breakfast cereal choice were found • Skippers had higher saturated fat intake and lower intake of dietary fibers and most micronutrients.
Kupers. Int J Obes (London) 2014;38(4).(67)	T1: N=1448 2 y/o M&F T2: N=1366 5 y/o M&F Netherlands	• Longitudinal • Parent-report questionnaires • Measured height and weight (cross-sectional data)	Frequency per week (0-7); eating daily: 7, not eating daily: <7	FFQ	T1: 3% skipped T2: 5.3% skipped	• No association between skipping and OW at either age. • Type of breakfast was not related to OW at 5 y/o. • May be too early/young to evaluate skipping as an issue.
Kuriyan. Indian Pediatr 2012:49(2).(68)	Total N=8444 N=4707 for 3-10 y/o N=3737 for 10-16 y/o M&F Bangalore	• Cross-sectional • Parent/student-report questionnaires • Measured height, weight, and WC	Breakfast skipping (yes/no)	Questionnaire	Not reported	• There was no effect seen between skipping breakfast on WC in children aged 3-10 y/o. • Skipping breakfast was associated with higher WC in children aged 10-16 y/o, however. • This study identified potential associations to WC in urban school children in India, but longitudinal studies with better measurements of adiposity are needed.
Polonsky. JAMA Pediatr 2019;173(4).(69)	N=1362 4th-6th graders M&F U.S.	• Cluster-randomized clinical trial across 2.5 years • Intervention schools received program that included breakfast in the classroom and breakfast-specific education • Control schools continued breakfast before school in cafeteria and standard nutrition education • Primary outcome was combined incidence of OW/OB; secondary included combined prevalence of OW/OB,	N/A	N/A	N/A	• No difference between intervention and control schools in the combined incidence of OW/OB after 2.5 years. • However, incidence and prevalence of OB were higher in intervention schools than in control schools after 2.5 years

Table 1 (continued)

		incidence and prevalence of OB, changes in BMI z-score, and School Breakfast				
Breakfast Consumption on Daily and Subsequent Dietary Intake						
Ho. Res Dev Disabil 2015;43-44:179-88.(48)	N=2401 Elementary school children M&F Taiwan	• Elementary School Children's Nutrition and Health Survey in Taiwan (NAHSIT) • Self-report questionnaire • Measured height, weight, WC and BP • Venous blood sample was collected for lipid profile and glucose metabolism	Breakfast consumption was assessed using question "How often do you eat breakfast in a week?" Answer could range from 0-7 times. The frequency was classified into three groups: 0-4, 5-6, and 7 times per week	24-h recall; FFQ US-YHEI modified to YHEI-Taiwan: indicator of diet quality	5.4%, 0-4 times/wk 5.9%, 5-6 times/wk 88.7% 7 times/wk	• Those who consumed breakfast daily had lower BMI and WC • Regular breakfast consumption was associated with higher diet quality. • Daily consumption associated with lower risk of high blood pressure and MetS. •
O'Neil. AIMS Public Health 2015;2(3).(50)	N=14200 2-18 y/o M&F U.S.	• Cross-sectional • Self-reported questionnaires (parent-reported for 2-5 y/o; parental assist 6-11 y/o; 12+ self-reported) • Measured weight and height	24-h dietary recall: no breakfast or 11 possible breakfast patterns	24-h dietary recall interviews using multiple-pass method	18.7% skipped	• BMI z-scores were lower among consumers of five breakfast patterns compared to breakfast skippers - Grain/lower fat milk/sweets/fruit juice - Pre-sweetened ready-to-eat cereal/whole milk - Soft drinks/fruit juice/grain/potatoes - Ready-to-eat cereal/whole milk • Cooked cereal/milk/fruit juice
Lepicard. J Hum Nutr Diet 2017;30(2).(62)	N=529 9-11 y/o M&F France	• Cross-sectional, observational • Total nutrient intake, mean adequacy ratio, energy density, and solid energy density calculated from breakfast food and fluid nutritional composition • Each breakfast item categorized into 15 solid and liquid food categories	Not having consumed no food or fluid for breakfast	1-day food diary	9.8% skipped	• Breakfast provided 22.9% energy intake and 24.7% of mean adequacy ratio of 23 key nutrients. • Four breakfast patterns identified: (1) sweets (40%); (2) traditional French (27.2%); (3) RTEC + milk (18.1%); and (4) dairy and juice (9.5%). • Nutritionally, the RTEC + milk breakfast was most advantageous; flavored milk was the most frequently consumed food (50.5%) and the major component of the traditional French breakfast
Deshmukh-Taskar. J Am Diet Assoc 2010;110(6).(63)	N=9659 9-18 y/o M&F	• Cross-sectional • Self-reported 24-hour recall over 2 days (with	Those who consumed no food or beverages,	Two 24-hour recalls	20% children	• Skippers had higher BMI z-scores and wc than ready-to-eat cereal and other breakfast consumers.

Table 1 (continued)

	U.S.	adult assistance for up to 11 y/o) • Measured weight, height, and wc	excluding water, at breakfast		31.5% adolescents	• Increased obesity in skippers than ready-to-eat cereal consumers.
Coulthard. Br J Nutr 2017;118(4).(65)	N=1686 4-18 y/o M&F UK	• Cross-sectional • Four-day food diary to be completed by children, or their parent for those aged 11 y/o and under • Measured weight and height	Those consuming breakfast every diary day, those consuming breakfast on at least one but not all diary days, and those not consuming breakfast on any diary day	4-day food diary	19.9% girls 14.5% boys	• No differences in weight status by breakfast eating habits. • Overall nutritional profile of the children in terms of fiber and micronutrient intake was superior in frequent breakfast eaters (micro: folate, calcium, iron, and iodine).
Fayet-Moore. Nutrients 2017;9(10).(66)	N=2812 2-18 y/o M&F Australia	• Cross-sectional • Face-to-face interviews • Measured weight and height	No breakfast during the 24 hours prior to interview day	24-h recall methodology	9% skipped	• No associations between anthropometric measures and breakfast or breakfast cereal choice were found • Skippers had higher saturated fat intake and lower intake of dietary fibers and most micronutrients.
Drewnowski. Nutrients 2018;10(9).(70)	N=14488 (total) N=4057 children N=10431 adults 6+ y/o M&F U.S.	• Examined breakfast nutrition in relation to overall diet quality • NHANES 2011-2014 • Diet quality assessed via Nutrient Rich Foods Index (NRF9.3) and USDA Healthy Eating Index-2015	Having no breakfast eating occasion or eating a "breakfast" <50 kcal	24-h recall	18% children skipped 19.7% adults skipped	• Breakfast intakes of carbohydrates and sugars were higher relative to breakfast energy • Breakfast intakes of proteins and fats were lower relative to breakfast energy • Breakfast provided more than 20% DRI of A, B, and D vitamins, calcium, iron, potassium, and magnesium • Breakfast consumption associated with higher NRF9.3 scores; those in top tertile had less added sugars and fats than bottom tertile • Breakfasts in higher tertile had more fruit and juices, whole grains, milk, and yogurt and less meat and eggs
Barr. Nutrients 2018;10(8).(71)	N=18287 6+ y/o M&F Canada	• Used 24-h recalls data from the 2015 Canadian Community Health Survey-Nutrition • Daily diet quality scores were assessed using the Nutrient-Rich Foods Index 9.3	No EO called "breakfast" during recall	24-h recall	10% skipped	• Breakfast consumers reported higher intake of energy and key nutrients and had higher daily diet quality scores • Among breakfast consumers, breakfast contributed to higher intakes of fruit, whole grains, and fluid milk, as well as associated nutrients (carbohydrate, total sugars, fiber, calcium, and vitamin D)

Table 1 (continued)

						• Among breakfast consumers classified by dietary quality, energy intake at breakfast did not differ across tertiles for either children or adults. • However, intakes of key nutrients, fiber, and total sugars increased across tertiles, and among adults, intakes of saturated fat and sodium decreased • Mean intakes of fruit, whole grains, and fluid milk also increased across tertiles, as did the proportion of individuals consuming these foods • Higher fruit and milk intakes may explain higher sugar intakes as diet quality increased • Promoting consumption of these foods at breakfast could contribute to improved diet quality among Canadians
Harland. Public Health Nutr 2008;11(6).(72)	N=15 studies N=119829 subjects 13 y/o+ M&F	• Systematic review • Analysis of observational studies reporting whole-grain consumption and measures of BW and adiposity, including macronutrient intakes and lifestyle factors • 15 trials were identified and included in the review	N/A	N/A	N/A	• BMI lower when high vs. low whole-grain intake was compared • In high consumers, adiposity (WC & W:H) was reduced • Higher intake of whole grains led to increased dietary fiber intake while total and saturated fat intakes decreased • People who consume more whole grains were likely to have a healthier lifestyle as fewer of them smoke, exercise more frequently, and have lower fat and higher fiber intakes
Afeiche. J Nutr 2017;147(3).(73)	N=3760 4-13 y/o M&F Mexico	• Cross-sectional • Used the 2012 Mexican National Health and Nutrition Survey • Examined total-day diet among breakfast consumers and skippers, identified and investigated breakfast dietary patterns (energy and nutrient intakes at breakfast and entire day)	No breakfast on recall day	One 24-hour recall	17% skipped	• Breakfast skippers had lower intake of several nutrients. • Nutrients to limit that were high in breakfast tended to be high for the total day and vice versa for nutrients to encourage.

Table 1 (continued)

Gaal. Nutrients 2018;10(8).(74)	N=8174 5-96 y/o M&F UK	• Aimed to investigate nutrient and food group intakes at breakfast and examine their relationship to overall diet quality • Used data from National Diet and Nutrition Survey 2008-14 • Food intake measured by 4-day estimated food diary • Diet quality was assessed by the Nutrient Rich Food Index 9.3	No food or drink items consumed between 6AM-11AM	Four-day food diary	6.1% irregular consumption 1.3% skipped	• Breakfast contributed 20-22% to total energy intake • Breakfast intakes of carbohydrate and non-milk extrinsic sugars (NMES) were higher, and intakes of protein, total fat, and saturated fatty acid were lower than relative daily intakes • Breakfast was rich in B vitamins, vitamin D, calcium, iron, iodine, and magnesium • From lowest to highest dietary quality tertile decreasing intakes of NMES, SFA, and total fat and increasing intakes of carbohydrate, protein, fiber, and most micronutrients were found • Findings could help inform the development of nutrient-based recommendations for a balanced breakfast for the first time in the UK
Kral. Am J Clin Nutr 2011;93(2).(75)	N=21 8-10 y/o M&F	• Aim was to test effects of consuming breakfast compared with omitting breakfast on appetite ratings and energy intake at subsequent meals in children • Each child participated in 2 BV visits during which they were served either a compulsory breakfast or no breakfast • On both visits, subjects were also served lunch, which was consumed ad libitum • Subjects rated their appetite throughout the morning • Parents completed food records that captured children's intake for the remainder of the day	Not served breakfast	Meals provided	N/A	• No significant main effect of breakfast condition on energy intake at lunch or throughout the remainder of the day • Significant main effect of breakfast condition on total daily energy intake, which indicated that on the day when the subjects did not eat breakfast, they consumed 362 fewer calories over the course of the day than when they did eat breakfast • On the day no breakfast was served, subjects indicated that they were significantly hungrier, less full, and could consume more food before lunch on the day when they did eat breakfast. • Omitting breakfast affected children's appetite ratings but not their energy intake at subsequent meals.
Reference	Subjects	Methods		Results/Conclusions		
Breakfast Protein Intake on Obesity and Metabolic Parameters						

Table 1 (continued)

Leidy. Obesity (Silver Spring) 2015;23(9).(76)	N=57 19 +/- 1 y/o M&F U.S.	• 12-week RCT • NP, HP, or skipped breakfast • Pre- and post-measurements included appetite, food intake, body weight, and body composition • Meals provided • NP=normal protein (13g) • HP=high protein (35g)	• HP prevented fat mass gains vs. control, whereas NP did not. • HP led to reductions in daily intake vs. control, whereas NP did not. • Only HP groups experienced reductions in daily hunger vs. control. • Directly comparing HP vs. NP, no differences were seen in any outcomes.
Kung. J Dairy Sci 2018;101(10).(77)	N=32 Avg. age 23.4 M&F Canada	• Randomized, controlled, double-blinded study • Investigate effect of casein-to-whey protein ratio and total protein concentration of milks consumed with cereal on postprandial glucose, appetite, and subsequent intake • Consumed either 80:20 or 40:60 ratio at normal or high protein (3.1% wt & 9.3% wt, respectively) – control was water consumption • Consumed a measured ad libitum pizza at lunch two hours later and blood glucose and appetite assessment continued after lunch meal (140-200 min)	• Pre-lunch (0-120 min) iAUC and mean change from baseline blood glucose were reduced with consumption of all milk treatments relative to water • High protein contrasted with normal protein lowered blood glucose change from baseline to iAUC and post-lunch appetite change from baseline and tAUC • High-cabrohydrate breakfasts with higher protein could be strategy to attenuate blood glucose and enhance satietu after second meal
Jakubowicz. J Nutr Biochem 2017;49:1-7.(78)	N=56 T2DM Avg. age 58.9 M&F	• Randomized to one of three isocaloric diets with similar lunch and dinner but varied breakfasts - 42g protein (with 28g whey) - 42g protein (various sources) - High-carbohydrate breakfast (17g protein from various sources) • BW and A1c were examined after 12 weeks • Three all-day meal challenges for postprandial glycemia, insulin, C-peptide, iGLP-1, ghrelin, and hunger and satiety scores	• Postprandial AUC glucose was reduced by 12% in PBdiet and 19% in WBdiet compared to CBdiet • WBdiet led to greater postprandial overall AUC for insulin, C-peptide, iGLP-1, and satiety scores, while postprandial overall AUC for ghrelin and hunger scores were reduced, when compared to PBdiet and CBdiet • After 12 weeks, A1c was reduced after WBdiet 0.89%, PBdiet 0.6%, and CBdiet 0.36%
Breakfast Protein Intake on Satiety and Hunger			
Gaal. Nutrients 2018;10(8).(74)	N=8174 5-96 y/o M&F UK	• Aimed to investigate nutrient and food group intakes at breakfast and examine their relationship to overall diet quality • Used data from National Diet and Nutrition Survey 2008-14 • Food intake measured by 4-day estimated food diary • Diet quality was assessed by the Nutrient Rich Food Index 9.3 • Breakfast skipping defined as no food or drink items consumed between 6AM-11AM	• 1.3% skipped; 6.1% irregularly consumed • Breakfast contributed 20-22% to total energy intake • Breakfast intakes of carbohydrate and non-milk extrinsic sugars (NMES) were higher, and intakes of protein, total fat, and saturated fatty acid were lower than relative daily intakes • Breakfast was rich in B vitamins, vitamin D, calcium, iron, iodine, and magnesium • From lowest to highest dietary quality tertile decreasing intakes of NMES, SFA, and total fat and increasing intakes of carbohydrate, protein, fiber, and most micronutrients were found

Table 1 (continued)

		• Four-day food diary	• Findings could help inform the development of nutrient-based recommendations for a balanced breakfast for the first time in the UK
Leidy. Obesity (Silver Spring) 2015;23(9).(76)	N=57 19 +/- 1 y/o M&F U.S.	• 12-week RCT • NP, HP, or skipped breakfast • Pre- and post-measurements included appetite, food intake, body weight, and body composition • Meals provided • NP=normal protein (13g) • HP=high protein (35g)	• HP prevented fat mass gains vs. control, whereas NP did not. • HP led to reductions in daily intake vs. control, whereas NP did not. • Only HP groups experienced reductions in daily hunger vs. control. • Directly comparing HP vs. NP, no differences were seen in any outcomes.
Leidy. Am J Clin Nutr 2013;97(4).(79)	N=20 19 +/- 1 y/o F only U.S.	• Randomized crossover design • Consumed 350-kcal cereal-based breakfasts, 350-kcal egg- and beef-rich breakfasts, or continued breakfast skipping for 6 days. • On day 7, 10-h testing day was competed using appetite and satiety questionnaires, blood sampling, predinner food cue-stimulated fMRI brain scans, ad libitum dinner, and evening snacking. • NP=normal protein (13g) • HP=high protein (35g) • Skipping breakfast defined as not eating breakfast for the 6-day period • Meals were provided	• Consumption of breakfast reduced daily hunger compared with BS. • Breakfast increased daily fullness compared with BS, with HP breakfasts eliciting greater increases than NP breakfasts. • HP reduced daily ghrelin and increased daily peptide YY concentrations compared with BS (but not NP). • Both reduced predinner amygdala, hippocampal, and midfrontal corticolimbic activation compared with BS. • HP led to additional reductions in hippocampal and parahippocampal activation compared with NP. • HP reduced evening snacking of high-fat foods compared with BS (but not NP). • No differences in daily energy intake.
Breakfast Sugar Intake on Daily and Subsequent Intake			
Barr. Nutrients 2018;10(8).(71)	N=18287 6+ M&F Canada	• Used 24-h recalls data from the 2015 Canadian Community Health Survey-Nutrition • Daily diet quality scores were assessed using the Nutrient-Rich Foods Index 9.3 • Breakfast skipper: no EO called "breakfast" during recall (one 24-h dietary recall)	• 10% skipped • Breakfast consumers reported higher intake of energy and key nutrients and had higher daily diet quality scores • Among breakfast consumers, breakfast contributed to higher intakes of fruit, whole grains, and fluid milk, as well as associated nutrients (carbohydrate, total sugars, fiber, calcium, and vitamin D) • Among breakfast consumers classified by dietary quality, energy intake at breakfast did not differ across tertiles for either children or adults. • However, intakes of key nutrients, fiber, and total sugars increased across tertiles, and among adults, intakes of saturated fat and sodium decreased • Mean intakes of fruit, whole grains, and fluid milk also increased across tertiles, as did the proportion of individuals consuming these foods • Higher fruit and milk intakes may explain higher sugar intakes as diet quality increased Promoting consumption of these foods at breakfast could contribute to improved diet quality among Canadians
Afeiche. J Nutr 2017;147(3).(73)	N=3760 4-13 y/o	• Cross-sectional	• 17% skipped • Breakfast skippers had lower intake of several nutrients.

Table 1 (continued)

	M&F Mexico	• Used the 2012 Mexican National Health and Nutrition Survey • Examined total-day diet among breakfast consumers and skippers, identified and investigated breakfast dietary patterns (energy and nutrient intakes at breakfast and entire day) • No breakfast on recall day • One 24-hour recall	• Nutrients to limit that were high in breakfast tended to be high for the total day and vice versa for nutrients to encourage.
Gaal. Nutrients 2018;10(8).(74)	N=8174 5-96 y/o M&F UK	• Aimed to investigate nutrient and food group intakes at breakfast and examine their relationship to overall diet quality • Used data from National Diet and Nutrition Survey 2008-14 • Food intake measured by 4-day estimated food diary • Diet quality was assessed by the Nutrient Rich Food Index 9.3 • Breakfast skipping defined as no food or drink items consumed between 6AM-11AM • Four-day food diary	• 1.3% skipped; 6.1% irregularly consumed • Breakfast contributed 20-22% to total energy intake • Breakfast intakes of carbohydrate and non-milk extrinsic sugars (NMES) were higher, and intakes of protein, total fat, and saturated fatty acid were lower than relative daily intakes • Breakfast was rich in B vitamins, vitamin D, calcium, iron, iodine, and magnesium • From lowest to highest dietary quality tertile decreasing intakes of NMES, SFA, and total fat and increasing intakes of carbohydrate, protein, fiber, and most micronutrients were found • Findings could help inform the development of nutrient-based recommendations for a balanced breakfast for the first time in the UK
Fallaize. Eur J Nutr 2013;52(4).(80)	N=30 Avg. age 21.7 M only UK	• Three-way crossover design • Randomized into one of three test breakfasts, on three separate occasions, spaced with one week between each - Eggs on toast - Cereal with milk and toast - Croissant and orange juice • Ratings on satiety, hunger, fullness, and desire to eat were recorded at 30-min intervals by VAS • Energy intake was evaluated by weighed food intake at ad libitum lunch and evening meal	• Increased satiety, less hunger, and a lower desire to eat after breakfast with eggs relative to cereal and croissant • Egg breakfast also had lower intake of energy relative to croissant and cereal breakfasts at the buffet lunch and evening meal, respectively • Higher protein breakfasts had an effect on satiety and subsequent intake
Laverty. Int J Behav Nutr Phys Act 2015;12:137.(81)	N=13170 7-11 y/o M&F UK	• Longitudinal study • UK Millennium Cohort Study • Study examined associations between SSB and ASB consumption and changes in adiposity	• Boys were more likely to consume SSBs weekly than girls at age 11 years. • South Asian children were more likely to consume SSBs weekly but less likely to consume ASBs weekly than Caucasian children. • Daily SSB consumption was associated with increases in percentage body fat between ages 7 and 11. • Daily ASB consumption was associated with increased percentage body fat at age 11 and greater increases between ages 7 and 11. • Consumption of SSBs and ASBs was associated with BMI and percentage body fat increases in UK children.

Table 1 (continued)

Seferidi. Pediatr Obes 2018;13(4).(82)	N=1687 4-18 y/o M&F UK	• National Diet and Nutrition Survey Rolling Programme in the UK • Evaluated associations between SSBs, ASBs, energy, and sugar (overall and from solid foods), BMI, WtH ratio, and blood analytes	• Compared with non-consumption, SSB consumption was associated with higher sugar intake overall and ASB with higher sugar intake from solid foods but not overall (mainly among boys) • On SSB consumption days, energy and sugar intakes were higher, and on ASB consumption days, sugar intake was lower compared to those on non-consumption days • SSB and ASB intakes were associated with higher blood glucose • SSB associated with higher TG
National School Lunch and Breakfast Programs			
Coleman-Jensen. USDA Econ Res Serv 2019.(33)	U.S. population	• Report on household food security in the U.S. in 2018	• Prevalence of food insecure households was 11.1% • 7.1% of households had food insecure children, resulting in inadequate amounts of nutritious foods • Rates of food insecurity were higher than the national average for Hispanic households at 16.2%
Bartfeld. Soc Serv Rev 2010;84(4).(83)	U.S. kindergarten children	• Article that examines determinants of SBP participation • Data came from Early Childhood Longitudinal Study-Kindergarten Cohort	• Participation is much less common in the SBP than NSLP, even among those who have access to both at school • SES, time constraints, and local norms are found to be linked to participation, with whether schools serve breakfast in classroom and length of time available for breakfast being predictive
Arteaga. Child Youth Serv Review 2014;47:224-30.(84)	U.S. kindergarten children	• Early Childhood Longitudinal Study- Birth cohort • Evaluates impact of NSLP on household food insecurity in households with a kindergarten-aged child	• Consistent support that NSLP reduces food insecurity • Paying full price for school lunch is associated with increases in food insecurity among low-income sample
Gundersen. Journal of Econometrics 2012;166(1).(85)	U.S. children	• Combined survey data to extend nonparametric partial identification models to account for endogenous selection and nonrandom classification error • Introduces new way to conceptualize MIV assumption	• Children in households reporting NLSP participation are more likely to have negative health outcomes than nonparticipants • Evidence supports that participation in free/reduced lunch improves health outcomes of children
Bartfeld. J Nutr 2011;141(3).(86)	N=3010 3rd graders M&F U.S.	• Examined relationship between availability of SBP and household FS • FS measured via 18-item FS scale	• Access to school breakfast reduced risk of marginal FS but not the risk of FS at standard threshold • Program beneficial in offsetting food-related concerns but not alleviating FI once hardships crossed threshold
Clark. J Am Diet Assoc 2009;109(2 Suppl).(87)	N=2314 1st-12th graders M&F U.S.	• Nutrient adequacy and excess were assessed by comparing usual nutrient intake distributions to DRIs and DGA, 2005 • Examines relationship between school program participation and prevalence of inadequate and excessive intakes	• Majority of public school children in U.S. had nutritionally adequate diets • 80% had excessive intakes of saturated fat and 92% had excessive intakes of sodium • Participation was associated with reduced prevalence of nutrient inadequacy but increased prevalence of excessive sodium intakes
Affenito. J Sch Health 2013;83(1).(88)	N=2298 5-18 y/o M&F	• Cross-sectional • Data from SNDA-III • Dietary recall and parental interview	• RTEC consumers had greater intake of vitamins A & C, calcium, iron, dietary fiber, and whole grain, relative to skippers

Table 1 (continued)

	U.S.	• Categorized as skipping vs. eating breakfast • Students eating breakfast were categorized by SBP participation and breakfast type (with or without RTEC)	
Robinson-O'Brien. J Sch Health 2010;80(10).(89)	N=103 4th-6th graders M&F U.S.	• From four urban elementary schools serving primarily low-income populations • Recorded dietary intake via 24-h dietary recall •	• 80% of children consumed fewer than 5 daily servings of FV • On average, children consumed more than half of their FV at school • Children with low FV intake consumed higher proportion of their daily intake at school than children with higher FV intake
Crepinsek. J Am Diet Assoc 2009;109(2 Suppl).(90)	N=130 public school districts N=398 schools	• Article updates national estimates of food energy and nutrient content of school meals and compares estimates to federal nutrient standards • Menu and recipe data for typical school week were collected • Nutrient information obtained from manufacturers to supplement Food and Nutrient Database for Dietary Studies used to analyze the data	• Most schools offered and served meals that met the standards for protein, vitamins, and minerals • Fewer than one-third of schools met the standards for energy from fat or SFA in average lunch • Three-fourths or more met fat standards in school brekafasts • For both meals, levels of sodium and fiber were low given FGA, 2005
Gleason. Mathematica Policy Research 2001.(91)	U.S. population	• Nutrition Assistance Program Report • Evaluates children's diets in the mid-1990s: dietary intake and its relationship with school meal participation	• Children have adequate intakes for most B vitamins, but many children of all ages are at risk of inadequate intakes of folate, magnesium, zinc, and vitamins A and E
USDA, Depart of Health and Hum Serv 2015.(92)	U.S. population	• U.S. Dietary Guidelines for Americans, 2015-2020	• No specific guidelines or recommendations exist for what constitutes a "healthy" breakfast. • Brief mention of including whole grains in breakfast meal
USDA, Food and Nutr Serv 2018.(93)	U.S. population	• Updated guidelines for Child Nutrition Program introducing flexibilities for milk, whole grains, and sodium requirements	• Current guidelines for SBP include 1 cup of dairy and fruit and 7-10 oz. equivalents of whole grains • However, dairy and fruit can be fulfilled by flavored milk and fruit juice, respectively, and only 50% of grains must be whole-grain rich
Breakfast Skipping Prevalence			
van Kleef. Appetite 2016;107:372-82.(36)	N=32 mothers N=44 children Netherlands	• Focus groups with mothers and children • Interviews with experts using interview guides that were developed based on the motivation, opportunity, and ability consumer psychology model •	• Themes emerged from focus groups: generally high motivation to have breakfast, improved performance at school is key motivator, limited time hinders breakfast, and lack of nutritional knowledge about high quality breakfast • Experts mentioned lack of time, financial constraints, and environmental issues (food availability) as barriers to consuming healthy breakfast • Experts perceived more problems and challenges in achieving healthy breakfast habits than did mothers and children • Lack of opportunity (according to children and experts) and ability (according to experts) were identified, even when motivation was present

Table 1 (continued)

Smith. Aust N Z J Public Health 2017;41(6).(52)	N=1592 2-17 y/o M&F Australia	• Cross-sectional • Computer-assisted interview based on 24-h recall methodology - 2-5 y/o completed by adult - 6-8 y/o adult interviewed with help from child - 9-11 y/o interviewed directly with assistance from adult - 12-17 y/o interviewed directly, with adult remaining in room for 12-14 y/o • Measured weight and height • Skipping: no eating occasion defined as "breakfast" in the 24-h recall or the energy intake for the occasion was <210 kJ	• 11.8% boys and 14.8% girls skipped on one day • 1.4% boys and 3.8% girls skipped on both days • Skipping breakfast was associated with being female, being older, being UW, OW, or OB – among others. • Odds of skipping breakfast were higher with increasing BMI category • Skipping breakfast was common but few consistently skipped. Interventions to increase breakfast consumption should target adolescents, particularly girls, and low SEP households.
Gibney. Nutrients 2018;10(5).(94)	Several countries	• Review • International Breakfast Research Initiative • Discusses various definitions of both breakfast meal and breakfast skipping and methods used to relate breakfast nutrient intakes to overall diet quality • Describes harmonized approach to study nutritional impact of breakfast	• Breakfast is not consumed daily for approximately one third to one half of children 11, 13, anf 15 y/o
Dwyer. J Am Diet Assoc 2001;101(7).(95)	N=1493 13-16 y/o M&F	• Data from Child and Adolescent Trial for Cardiovascular Health (CATCH) • In-person 24-h dietary recalls were obtained	• Fewer students ate breakfast than any other meal • 20% ate lunch and dinner only • Those who ate fewer meals ate more snacks • Among snackers, boys consumed more energy from snacks than girls and more of all other nutrients examined when they were expressed in mass units • Breakfasts provided the least amount of energy • Absolute amounts of all nutrients increased as number of eating occasions increased
Murata. Am J Clin Nutr 2000;72(5 Suppl).(96)	Japan population 1-19 y/o M&F	• National Nutrition Survey 1994 (3d) • Government report data	• Children and adolescents skip breakfast more than any other meal • Prevalence of skipping increases across age groups (1-6 y/o,7-14 y/o,15-19 y/o)
Shaw. Adolescence 1998;33(132).(97)	N=699 13 y/o M&F Australia	• Sample came from Mater Hospital-University of Queensland Study of Pregnancy • Only children who completed questionnaire on food and eating habits were included (how breakfast was assessed)	• ~12% skipped breakfast • Gender was the only statistically significant sociodemographic variable, with females skipping at over three times the rate of males. • Skippers were more likely to be dissatisfied with their body shape and to have been on a diet to lose weight than were those who ate breakfast. • In follow-up phone interview, however, reasons for skipping were exclusively due to lack of time and not being hungry in the morning.

Table 1 (continued)

		• Respondents were asked how often they ate breakfast, and if they did not, their reasons for skipping. • Supplementary data were collected via a telephone survey approximately one year after questionnaires were completed	
Overby. Pediatr Diabetes 2008;9(4 Pt 2).(98)	N=655 M&F Norway	• Population-based (diabetics) • Dietary intake recorded in 4-day food diary • Number of meals and snacking occasions recorded in separate questionnaire • Clinical data collected from record forms • Skipping meals referred to consuming a main meal (e.g., breakfast) five times a week or less	• Fewer young diabetic patients who skip meals than non-diabetic controls, even when using intensified insulin treatment • Skipping meals among young diabetics was associated with suboptimal A1c, higher LDL, watching more TV, being OW, higher intake of added sugar, and lower intake of fiber compared to those not skipping meals • Having > 2 snacking occasions during the day was associated with higher A1c, higher intake of added sugar and sweets, and spending more time in front of TV/computer.
Rodrigues. Nutrition 2017;42:114-20 e1.(99)	N=1139 14-19 y/o M&F Brazil	• School-based, cross-sectional study • Consumption of breakfast, morning snack, lunch, afternoon snack, and dinner was assessed • BHEI-R evaluated diet quality • Diet characterized by unhealthy eating: low consumption of FV and milk/dairy; high consumption of fats and sodium	• Unsatisfactory meal profile observed in 14% • Daily consumption of breakfast, lunch, and dinner was reported by 47%, 78%, and 52%, respectively • Meal profile positively associated with diet quality • Daily breakfast consumption associated with higher BHEI-R scores, lower sodium intake, and greater consumption of fruits and milk/dairy • Daily lunch consumption associated with greater consumption of vegetables and "meats, eggs, and legumes” • Daily dinner consumption associated with an increased consumption of "whole fruits"
Ramsay. Eur J Clin Nutr 2018;72(4).(100)	N=3443 2-5 y/o N=5147 6-12 y/o M&F U.S.	• Cross-sectional • Dietary recalls from NHANES 2005-2012 • Dietary intakes and diet quality scores were compared between breakfast consumption and skipping breakfast	• Skippers had lower energy intake for total day but had greater energy intake from non-breakfast meals and snacks • Children who skipped breakfast consumed nearly 40% of the total intake from snacks with much coming from added sugar • Skipping breakfast was related to lower intakes of fiber, folate, iron, and calcium intakes • Diet quality scores and fruit, whole fruit, whole grains, dairy, and empty calories subscale scores were significantly better in children who ate breakfast
Food Insecurity on Breakfast Consumption			
Papas. J Immigr Minor Health 2016;18(5).(34)	N=74 Mother-child dyads U.S.	• Cross-sectional • USDA 18-item Household Food Security Survey was used to determine food security status • Investigated association between food insecurity and OB among low-income, Hispanic dyads	• 74% of households were food insecure and one-third of children were OB • FI increased odds of childhood OB; stronger associations in households where mothers were OW/OB compared to NW

Table 1 (continued)

Potochnick. J Adolesc Health 2019;64(5).(35)	N=1362 8-16 y/o M&F Latino youth U.S.	• Cross-sectional • Hispanic Community Children's Health Study of Latino Youth • Examined correlates of household and child food insecurity and very low food security • Assessed four sets of risk/protective factors: child demographic, acculturation, socioeconomic, and family/social support • Also examined BMI, diet quality, depression, and anxiety	• Found high rates of food insecurity: Hispanic/Latino youth 42% • 10% lived in very low food secure households • Hispanic/Latino youth in food insecure households experienced greater acculturative and economic stress and weakened family support systems compared to food secure peers
van Kleef. Appetite 2016;107:372-82.(36)	N=32 mothers N=44 children Netherlands	• Focus groups with mothers and children • Interviews with experts using interview guides that were developed based on the motivation, opportunity, and ability consumer psychology model •	• Themes emerged from focus groups: generally high motivation to have breakfast, improved performance at school is key motivator, limited time hinders breakfast, and lack of nutritional knowledge about high quality breakfast • Experts mentioned lack of time, financial constraints, and environmental issues (food availability) as barriers to consuming healthy breakfast • Experts perceived more problems and challenges in achieving healthy breakfast habits than did mothers and children • Lack of opportunity (according to children and experts) and ability (according to experts) were identified, even when motivation was present
Dykstra. J Nutr 2016;146(3).(101)	N=821 4^{th}-6^{th} graders M&F U.S.	• Cross-sectional • Included 16 elementary schools • Foods/drinks reported by students on morning of collection • Parents reported household food security status using 6-item FS Survey Module • School district provided SBP participation data during the fall semester of 2013 • Three levels of household food security - Food secure - Low food secure - Very low food secure	• SBP-eligible students participated only 31.2% of possible days • 13% never participated • 19.4% of students purchased something from a corner store for breakfast • 16.9% skipped breakfast • 46% FI
Liu. J Nutr 2020;150(3).(102)	N=472 18+ y/o M&F U.S.	• Observational, cross-sectional • Investigated association of breakfast consumption with diet quality and nutrient intake among food pantry clients in rural communities • 24 food pantries in rural high-poverty counties • Surveyed at pantry regarding diet using 24-h dietary recall • Second recall was completed via assisted phone call within 2 weeks of pantry visit	• 56% consumed breakfast • Compared to skippers, consumers had 10-59% higher usual mean intakes of all nutrients and had 12-21% lower prevalence of at-risk nutrient intakes except for vitamin D, vitamin E, and magnesium

Table 1 (continued)

		• Classified as breakfast skippers when neither 24-hour dietary recall reported breakfast >=230 kcal consumed between 4AM-10AM • HEI-2010 to evaluate dietary quality • Mean usual intake of 16 nutrients was estimated using the National Cancer Institute Method and compared across breakfast patterns • Usual nutrient intake compared with EAR or AI to estimate the proportion of population not meeting the EAR or exceeding the AI	

Chapter 2: Manuscript

INTRODUCTION

Obesity prevalence has nearly tripled since 1975, affecting 18.5% of children and adolescents in the U.S., with those of Hispanic origin disproportionately affected at 25.8% (1). Breakfast consumption has been a target of ongoing research in both predicting and preventing overweight and obesity prevalence (43). Metabolic and physiological benefits of breakfast consumption in children include improved lipid panels, glucose control, and blood pressure and decreased fasting insulin (48, 57, 58, 103). Breakfast consumption is associated with lower cardiometabolic risks (43), including dyslipidemia (59), and lower metabolic syndrome risk in children (48, 57, 60, 61). However, few studies have evaluated breakfast consumption on cardiometabolic risks in primarily low-income, Hispanic children.

Despite breakfast consumption being associated with improved health outcomes in children and adolescents (45-54), the International Breakfast Research Initiative reports that only one third to one half of older children (11-15 years of age) consume breakfast every day (94). In addition, the prevalence of skipping breakfast has been shown to increase with age (104). Children and adolescents skip breakfast more than any other meal (95, 96), with one study showing higher prevalence of skipping in Hispanic youth (32%) when compared to Caucasian youth (19%) (95). Primary reasons for skipping breakfast include financial constraints and having inaccessibility to appropriate breakfast foods (36). Hispanic households have higher prevalence of food insecurity, which has been associated with increased obesity prevalence in Hispanic children (34, 35). Nonetheless, while evidence supports the daily consumption of breakfast, studies have found conflicting results to substantiate this evidence. Some studies have shown a null association between breakfast consumption and weight management while others have found a positive association (65-69). Potential reasons for the conflicting findings could be attributed to the quality of foods consumed at breakfast and/or the influence of breakfast on the overall diet.

Breakfast consumption is associated with meeting dietary intake recommendations and having superior overall diet quality in children (48, 63, 70). Independent of breakfast consumption, breakfast composition has been associated with varied dietary quality (62, 63). Measures of dietary quality included evaluation of micronutrients, specifically shortfall nutrients (i.e., vitamin E, calcium, magnesium, iron, and zinc), and use of the Nutrient Rich Foods Index and the USDA HEI-2015 (62, 63, 70). While associated with higher overall diet quality, regular breakfast consumers display higher intakes of saturated fats (48), sweets (62), and flavored milk (62) at breakfast, potentially eliciting a negative effect on adiposity and weight management. These counterintuitive findings could be due to fortification of common breakfast foods (i.e. cereals, nutrition bars, etc.) that tend to be high in saturated fats and added sugars, while still providing vitamins and minerals that contribute to diet quality. Furthermore, Deshmukh-Taskar et al. posed that consumption of milk at breakfast contributed to increased calcium intake (63). Similar to flavored milk, this could explain why higher overall diet quality is observed, regardless of its other negative qualities.

These inconsistencies highlight the complex interaction between breakfast consumption and body weight, metabolism, and dietary habits. The evaluation of breakfast consumption is limited in primarily low-income and Hispanic populations, especially children. This study aims to assess the relationship between breakfast consumption on adiposity, metabolic parameters, and total and subsequent dietary intake in primarily low-income, Hispanic elementary school-aged children. We hypothesize that increased breakfast consumption is associated with decreased cardiometabolic risks and increased dietary quality.

METHODS

Study Design. This cross-sectional study used baseline data from TX Sprouts, a school-based cluster randomized controlled gardening, nutrition, and cooking intervention. The study design for the TX Sprouts intervention has been described in detail elsewhere (105). TX Sprouts recruited 3rd-5th grade students and their parents from 16 elementary schools in the Greater Austin, TX, area. All schools had to meet the following inclusion criteria: (1) high proportion of Hispanic children (>50%); (2) high proportion of children enrolled in the free and reduced lunch (FRL) program (>50%); (3) location within 60 miles of the University of Texas at Austin campus; and (4) no pre-existing school garden or gardening program. The first 16 schools that met criteria and agreed to participate were randomly assigned to receive the intervention (n=8 schools) or delayed intervention (n=8 schools), serving as the control group. This trial was registered at ClinicalTrials.gov (NCT02668744).

Study Population. There was a total of 3,302 students who obtained parental consent to participate in TX Sprouts. Of those, clinical data was collected on 3,135. Dietary recalls were collected on a subsample of 760 children – of which 23 had completed only one 24-hour recall and were thus omitted. Thereafter, students were excluded from analyses for missing anthropometric data (n=32) and demographic data (n=56). In addition, one student was omitted due to the breakfast energy cut point. The total analytical sample was 671 students. **Figure 1** provides a detailed consort diagram showing participant flow through the study.

Recruitment. All 3rd-5th grade students and parents of the recruited schools were contacted to participate via information tables at "Back to School" and "Meet the Teacher" events, flyers sent home with students, and classroom announcements made by teachers. Recruitment materials were available in both English and Spanish. Both consent and assent were required for inclusion in the study. Written informed consent was obtained from the parents, and assent was obtained from each student to participate in the parent intervention and child measurements, respectively. All procedures pertaining to human subjects were approved by the Institutional Review Boards of The University of Texas at Austin and all associated school district review boards.

Anthropometric Parameters. Height was measured using a free-standing stadiometer to the nearest 0.1 cm (Seca, Birmingham, UK). Waist circumference was measured using National Health and Nutrition Examination Survey (NHANES) protocol (106). Weight and bioelectrical impedance were assessed with a Tanita Body Fat Analyzer (Tanita Corporation of America Inc, IL, USA, model TBF 300). BMI percentiles were determined using Centers for Disease Control and Prevention (CDC) age- and gender-specific values (107). Blood pressure was measured with an automated monitor with child or adult cuffs (Omron, Schaumberg, IL).

Metabolic Parameters. Optional fasting blood draws were collected before the school day between 6AM and 7AM on a subsample of students at baseline. Those who opted to not participate in the blood draw were still able to participate in all other TX Sprouts evaluations and activities. Eligible students and their families received flyers and text message reminders about the optional blood draws and to come in fasting, having nothing to eat or drink other than water after midnight. Blood samples were collected by certified phlebotomists or nurses with experience drawing blood in children with obesity and were conducted in a private room at the schools. Students received a $20 incentive for participation in the blood draw. Samples were collected on site and transported on ice to the University of Texas at Austin laboratory.

Clinical Laboratory Improvement Amendments (CLIA) certified glucose using HemoCue Glucose 201 (HemoCue America, Brea, CA). Due to a larger than expected proportion of students having prediabetes using the American Diabetes Association definition (108), HbA1c measurement was added in the last two waves, explaining the lower number of samples and values observed for HbA1c. HbA1c assays using DCA Vantage Analyzer (Siemens Medical Solutions, Malvern, PA) were performed on whole blood. Insulin was evaluated using an automated enzyme immunoassay system analyzer (Tosoh Bioscience, Inc. San Francisco, CA). Total cholesterol, high-density lipoprotein (HDL), and triglyceride levels were measured using Vitros chemistry DT slides (Ortho Clinical Diagnostics Inc., Rochester, NY); low-density lipoprotein (LDL) was calculated using the Friedwald equation (109).

Dietary Parameters. Dietary intake was collected using a validated two 24-hour dietary recall method on a random subsample of children at baseline (110). Sixteen students (eight male and eight female) were randomly selected from each grade level at each school to be contacted for recalls (n=48/school). If any of the 16 originally selected students were unavailable or did not want to participate in recalls, then additional students were randomly selected to take their place. Recalls were collected via telephone by trained staff and supervised by a Registered Dietitian Nutritionist using Nutrition Data System for Research (NDS-R, 2016 version), a computer-based software application that facilitates the collection of recalls in a standardized fashion (111). NDS-R generated nutrient and food/beverage servings and groupings, and HEI-2015 scores were calculated to assess dietary quality (112-115). The HEI-2015 is composed of thirteen food components representative of the dietary recommendations based on the *Dietary Guidelines for Americans, 2015-2020*. These HEI-2015 components are divided into two groups: nine adequacy components (i.e., greens and beans, total fruits and vegetables, whole fruits, dairy, while grains, total protein foods, seafood and plant proteins, and fatty acids) and four moderation components (i.e., sodium, added sugars, refined grains, and saturated fat). Higher adequacy component scores are indicative of higher intake while higher moderation component scores are indicative of lower intake. The individual component scores are summed to an overall total HEI-2015 score ranging from 0 to 100. Higher HEI-2015 scores indicate higher dietary quality, per the *Dietary Guidelines for Americans, 2015-2020*.

Dietary intake data gathered by interview was governed by a multiple-pass interview approach (116). Prior to the dietary recalls, Food Amounts Booklets, developed by the Nutrition Coordinating Center (NCC), were distributed to and sent home with the students. The booklets were provided in both English and Spanish and contained pictures of serving sizes to assist students in estimating serving sizes of foods and beverages reported during the dietary recall. Parents and/or guardians were allowed to assist with information regarding food items and portion sizes when needed. Students received a $10 incentive upon completion of both 24-hour dietary recalls. Quality assurance was conducted on all dietary recall data by additional trained research staff.

Breakfast Parameters. During each 24-hour dietary recall, students were asked to name each eating occasion (EO) and the time of day when the EO occurred. Response options included: breakfast, brunch, lunch, dinner/supper, snack, beverage only, school lunch, or other. Dietary values were averaged across the two days of recall information to obtain mean values of consumption. Students were classified as breakfast consumers if they referred to an EO as "breakfast" and the energy intake was at least 15% of total daily energy and consumption occurred before 10 AM. These criteria have been shown as an appropriate method for defining a breakfast meal (117-120). If two breakfasts were consumed on the same day before 10 AM (i.e. one from home and one from school), then dietary values were combined before averaging with the second dietary recall.

In line with previous work evaluating breakfast consumption (55, 63, 121, 122), breakfast consumption groups (BCG) were defined using the dietary recall data: (1) SKIPPERS, having no breakfast EO on either recall day; (2) INTERMITTENT, having a breakfast EO on only one recall day; and (3) REGULAR, having a breakfast EO on both recall days.

Statistics. Data were examined for normality, and transformations were made if data deviated from normality. All variables were transformed for normality except BMI z-score, fasting plasma glucose, HEI scores, carbohydrate (% kcal), fat (% kcal), total sugar (% kcal), breakfast carbohydrate (%kcal), breakfast fat (% kcal), breakfast total sugar (% kcal), breakfast whole grains (serv/d), breakfast refined grains (serv/d), subsequent energy (kcal), subsequent fat (% kcal), and subsequent carbohydrate (% kcal). The negative reciprocal method was used for HbA1c (%) and diastolic BP (mmHg). The square root method was used for added sugar (% kcal), breakfast protein (% kcal), subsequent total sugar (% kcal), and whole grains (serv/d). The cubed method was used for BMI percentile (%). All other variables were log transformed.

Analysis of covariance was used to assess differences in adiposity, metabolic, and dietary characteristics between the three BCG. Mean total energy served as a covariate in the models regarding daily intake and breakfast composition (**Tables 3 & 4**), and mean total breakfast energy served as a covariate in the model for subsequent intake (**Table 5**). For those with protein (% kcal), carbohydrate (% kcal), and fat (% kcal) as the outcome variables, complementary macronutrient percentages were included as covariates. All models with a dietary variable as the outcome included a covariate controlling for whether the dietary recalls were from two weekdays, one weekday/one weekend day, or two weekend days. *A priori* covariates for all models included age, sex, race/ethnicity, BMI z-score, and FRL status. All analyses were performed using Stata version 16.0 (StataCorp, College Station, TX, USA), and the significance was set at $P < 0.05$.

RESULTS

The basic demographic, anthropometric, and dietary characteristics data are presented in **Table 2**. The sample was 54% female and the average age was 9.3 years of age, with 58% being Hispanic. The mean BMI percentile was 71.6%, and nearly 49% of children had overweight or obesity. Additionally, the mean HEI score was 53.8 (SD: ±12.3). **Table 3** presents adiposity and metabolic measurements between breakfast consumption groups. There were no differences between any of the adiposity or metabolic measures between breakfast consumption groups. Due to minor trends observed in waist circumference and BMI z-score ($p=0.09$ & $p=0.12$, respectively), a Pearson's chi-square test was done to determine if these trends were a result of heterogeneous distributions of overweight and obese children between the BCG; however, the result was insignificant and showed homogeneous distributions between the BCG.

Table 4 presents dietary characteristics between the breakfast consumption groups. On average, there were more eating occasions observed in REGULAR than INTERMITTENT and SKIPPERS ($p<0.001$ & $p<0.001$, respectively). INTERMITTENT had significantly more eating occasions than SKIPPERS ($p<0.001$). Differences in total HEI scores were detected between the groups, with REGULAR consumers having 4.1% higher scores than SKIPPERS ($p=0.009$) and 3.3% higher than INTERMITTENT ($p=0.033$). No differences were detected between SKIPPERS versus INTERMITTENT. REGULAR had lower daily intake vs. INTERMITTENT ($p=0.003$) but not compared to SKIPPERS. Daily macronutrient composition was also different between groups. Daily carbohydrate consumption was higher in REGULAR compared to INTERMITTENT ($p<0.001$) and SKIPPERS ($p<0.001$). INTERMITTENT consumed more daily carbohydrates than SKIPPERS ($p<0.001$). REGULAR consumed more daily protein than INTERMITTENT ($p<0.001$) and SKIPPERS ($p<0.001$). INTERMITTENT consumed more daily protein than

SKIPPERS (p<0.001). Lastly, REGULAR consumed lower daily fat compared to INTERMITTENT (p<0.001) and SKIPPERS (p<0.001), with INTERMITTENT consuming less than SKIPPERS (p<0.001).

Daily soluble fiber intake was higher in REGULAR versus INTERMITTENT (p=0.029) and SKIPPERS (p<0.001). While daily total sugar consumption was higher in REGULAR (p<0.001) and INTERMITTENT (p<0.001) compared to SKIPPERS, INTERMITTENT had higher daily total sugar consumption than SKIPPERS (p=0.007). In addition, REGULAR and INTERMITTENT had higher daily added sugar consumption than SKIPPERS (p=0.006 & p=0.003, respectively). Daily fruit consumption (including 100% juice) was higher in REGULAR versus INTERMITTENT (p=0.009) and SKIPPERS (p=0.003). However, when 100% juice was excluded, this difference was attenuated. Daily consumption of whole grains was higher in REGULAR (p=0.002) and INTERMITTENT (p=0.026) versus SKIPPERS. However, there was no significant difference in refined grain intake between groups. No differences in dairy, vegetables, and meat servings were observed between groups.

Table 5 presents the composition of breakfasts between REGULAR and INTERMITTENT groups. REGULAR consumed more energy at breakfast than INTERMITTENT (p<0.001). Breakfast protein and insoluble fiber were higher in REGULAR when compared to INTERMITTENT (p<0.001 & p=0.041, respectively). REGULAR had lower consumption of added sugar at breakfast compared to INTERMITTENT (p=0.034). Whole grain consumption at breakfast was higher in REGULAR versus INTERMITTENT (p<0.001).

Composition of subsequent intake between breakfasts groups is shown in **Table 6**. REGULAR consumed fewer calories throughout the day than INTERMITTENT (p<0.001) and SKIPPERS (p<0.001). REGULAR consumed less added sugar throughout the day than

INTERMITTENT ($p=0.003$) and SKIPPERS ($p<0.02$). REGULAR consumed higher protein throughout the day versus SKIPPERS ($p=0.03$) but not compared to INTERMITTENT. REGULAR consumed less refined grains than INTERMITTENT ($p=0.02$) and SKIPPERS ($p<0.001$).

DISCUSSION

Contrary to our hypothesis, this study evaluating low-income, Hispanic elementary school-aged children found no protective effects of breakfast consumption on adiposity and metabolic parameters. While breakfast consumption was linked to higher consumption of total and added sugar, it was also associated with higher total HEI-2015 dietary quality scores; higher total protein and fruit juice intake; and lower total fat, energy, and refined grain intake. The link between breakfast consumption and both unhealthy and healthy dietary intake may explain the null effects of breakfast on adiposity and metabolic outcomes.

Comparing breakfast consumption groups, regular breakfast consumers had higher HEI scores than intermittent breakfast consumers and breakfast skippers. The USDA reports that children (6-17 years of age) have an average HEI-2015 score of 53 out of 100, which is the lowest of all other age groups (123). The average HEI-2015 in the current study was 53.8, similar to the national average for children in this age range (123). Children who regularly consumed breakfast were the only group to have a HEI-2015 score higher than the national average at 55.7. These results are consistent with other studies showing that those who consume breakfast have higher diet quality (48, 65, 66, 71, 74).

Aside from overall diet quality, those who regularly consumed breakfast had lower daily intake of total fat and higher daily intake of total protein and soluble fiber, factors that are typically associated with reducing adiposity (124-128). Breakfast consumers also consumed more daily servings of whole grains than skippers, which likely contributed to the higher soluble fiber finding. Literature supports that whole grain consumption is associated with decreased adiposity as well (72). Alternatively, those who regularly consumed breakfast had a higher intake of total sugar and added sugar, including more servings of fruit with 100% juice than breakfast skippers. However, this association was attenuated when excluding 100% juice, which is a primary source of total sugar intake. It is well-established that sugar consumption has been positively associated with adiposity and blood glucose (81, 82, 129, 130) and that whole fruit consumption leads to a greater reduction in hunger than consuming the same amount in fruit juice, with soluble fiber serving a prominent role (131, 132). Flood-Obbagy et al. showed that whole fruit consumption increased satiety more than fruit, fruit juice, and fruit juice with fiber, independent of energy density or fiber content (133). Despite regular and intermittent consumers having higher daily consumption of fruit juice than breakfast skippers, daily soluble fiber consumption remained superior in regular consumers. The association between regular breakfast consumption and soluble fiber was not seen, however, looking solely at breakfast composition nor subsequent intake. As daily consumption of 100% fruit juice was driving the differences observed between breakfast consumption groups, it is possible that increased consumption of juice contributed to the null effects of breakfast consumption on anthropometric and metabolic parameters.

Differences were also observed in both the composition of breakfast between those who regularly consumed breakfast and those who intermittently consumed breakfast and subsequent intake between all breakfast consumption groups. Regular consumers had a greater intake of energy, protein, total fiber, insoluble fiber, and whole grains at breakfast when compared to intermittent consumers. When replacing insoluble fiber with soluble fiber, all results were consistent with what was observed in total daily dietary intake between regular and intermittent consumers. These associations suggest that those who consume breakfast regularly have higher dietary quality of breakfast than those who do not, which could be driving the higher daily diet quality that was observed for this group. Additionally, those who consumed breakfast regularly had lower intake of energy throughout the day than those who consumed breakfast intermittently or skipped altogether. This could be due to those who consumed breakfast regularly having a higher energy breakfast, suggesting that higher energy intake in the morning decreases energy intake throughout the day, which has been supported in literature (75, 134).

Regular breakfast consumption was associated with lower consumption of both added sugar and refined grains throughout the day than intermittent breakfast consumers and breakfast skippers, which could be due to the higher consumption of whole grains at breakfast observed in this group. Whole grain consumption has been associated with high fiber intake (119), increased postprandial satiety (135, 136), decreased hunger (136), and reduced energy intake in subsequent meals (137). Consistent with other studies, the current study found associations between high protein intake at breakfast and less daily energy and total fat intake (76, 79), while also being associated with high sugar consumption at breakfast (62, 71). Whole grain intake at breakfast has been associated with low fat intake throughout the day (119), but protein intake at breakfast could be mediating some of these results.

Regular breakfast consumers had higher protein intake than intermittent breakfast consumers and breakfast skippers for the day and for breakfast and had higher protein intake than breakfast skippers throughout the day. High protein breakfasts have been associated with a reduction in daily hunger and increased satiety in adolescents with overweight and obesity when compared to skipping breakfast (76, 79), with one showing that high protein breakfasts (40% of meal) elicited stronger satiety responses than normal protein breakfasts (15% of meal) (79).

Regular breakfast consumers had a mean protein intake of 16.9% for the day. The *Dietary Guidelines for Americans, 2015-2020* recommends that children 4-13 years of age should consume a diet of 10-30% protein daily (92). Since the observed protein intake in this cohort is on the lower end of the recommendation (Mean ±SD: 16.2 ±3.8), higher protein intake, either at breakfast or for the day, could lower intake of deleterious contributors, such as added sugar.

Both regular and intermittent consumers had higher added sugar intake for the day than skippers. For intermittent consumers, there could be a mechanism by which breakfast irregularity contributes to the choice of convenient foods and/or beverages higher in added sugar not only for breakfast but also throughout the day. Similarly, skipping meals has been associated with more snacking events and low diet quality, particularly low intake of fruits and vegetables and high intake of sodium, calories from fat, and added sugars (98, 99). Ramsay et al. not only showed that breakfast skippers had greater energy intake from other meals and snacks, but also that skippers consumed nearly 40% of daily intake from snacks, with added sugar contributing to 25% of energy from snacks (100). As the daily intake of added sugar in intermittent eaters is an average of the two days, greater intake of added sugar on the day breakfast was not consumed could explain the higher intake observed when compared to skippers. Furthermore, Afeiche et al. showed that breakfast meals composed of higher added sugar and sodium was associated with higher consumption of added sugar and sodium throughout the day (73). This suggests that added sugar consumption at breakfast could be moderating added sugar consumption throughout the day.

Lastly, consumption of sugar has been studied as a food addiction. Lennerz and Lennerz regards food addiction as a plausible etiological factor that contributes to obesity that can be explained by three concepts: responses to certain foods are similar to those of substance abuse, food intake regulation and addiction have similar neurobiological circuits, and individuals who have obesity or an addiction show similar neurochemical and brain activity (138). Looking at food addiction in children with overweight, Filgueiras et al. showed that 95% of children (n=139) showed at least one sign of food addiction, with 24% being diagnosed with food addiction and higher added sugar and ultra-processed food consumption as main contributors to food addiction (139). As added sugar has been associated with breakfast consumption and properties of addiction, it could be that consumption of such foods for breakfast at the beginning of the day could lead to higher consumption throughout the day, contributing to overweight and obesity prevalence.

Limitations. The current study had some limitations for consideration. First, the sample is predominantly Hispanic, so we were unable to distinguish any breakfast patterns or dietary composition by race or ethnicity. In addition, nearly 49% of children in this sample are classified as having overweight or obesity, so the sample is rather homogenous, and breakfast may not have a robust effect to elicit a response in our population. However, given the higher prevalence rates of obesity in Hispanic youth (1), it is important to examine dietary behaviors that are linked to obesity in this high-risk homogenous population. Another limitation to the current study is that there is no standard definition of breakfast, especially in the context of children, so it is possible that some of these results could be due to the chosen definition. The *Dietary Guidelines for Americans, 2015-2020* does not contain a standardized definition or recommendation for breakfast and posits that more research is needed to determine such recommendations (92). The energy cut point of 15% daily energy was chosen to exclude meals that were very low or no energy foods and beverages, i.e. a glass of water, single banana, nutrition bar, etc. Furthermore, the recommended amount of energy to be consumed at breakfast is dependent on the total number of EOs throughout the day (118). Due to the lower number of EOs observed in Hispanic children (6-11 years of age) from the *What We Eat in America* data tables, the lower end of 15% daily energy proved appropriate for the definition of breakfast in this study and has been recommended as the minimum energy requirement (118, 140). The recommendation for the breakfast energy threshold is 25%, but Hispanic children (6-11 years of age) consume, on average, 23% of daily energy at breakfast, so an upper limit of 25% did not seem appropriate (118, 141). Lastly, dietary recalls were collected for only two days, which may not be indicative of usual intake.

Conclusion. In conclusion, although breakfast consumption was not associated with lower adiposity or healthier metabolic parameters, frequent breakfast consumption was linked to higher total HEI-2015 diet quality scores; higher consumption of daily dietary protein and fruit juice; and lower total energy, dietary fat, and refined grain intake. However, we believe the higher sugar intake of breakfast consumers played a role in masking the relationship with breakfast on adiposity and metabolic parameters. The results suggest that quality of foods consumed at breakfast plays a pivotal role in whether or not benefits of breakfast consumption are received.

Table 2. Characteristics of low-income, Hispanic children[a]

n=671	Value
Physical Characteristics	
Sex (F)	364 (54.3%)
Age (years)	9.3 ±0.9
Ethnicity	
Hispanic	392 (58.4%)
Non-Hispanic	279 (41.6%)
Free/Reduced Lunch	446 (66.5%)
Height (cm)	138.4 ±8.9
Weight (kg)	39.4 ±11.9
BMI percentile (%)	71.6 ±28.6
BMI z-score	0.8 ±1.1
BMI categories	
Overweight	129 (19.2%)
Obese	198 (29.5%)
Dietary Characteristics	
Eating occasions	3.3 ±0.8
Healthy Eating Index-2015	53.8 ±12.3
Total energy (kcal/d)	1446.2 ±541.6
Carbohydrate (% kcal)	49.7 ±8.8
Protein (% kcal)	16.2 ±3.8
Fat (% kcal)	33.3 ±6.9
Total fiber (% kcal)	3.5 ±1.3
Soluble fiber (% kcal)	1.1 ±0.4
Insoluble fiber (% kcal)	2.4 ±1.0
Total sugar (% kcal)	20.7 ±7.8
Added sugar (% kcal)	10.1 ±5.9
Food/Beverage servings[b]	
Total vegetables	1.7 ±1.3
Excluding 100% juice	1.7 ±1.3
Excluding 100% juice and potatoes	1.5 ±1.2
Total Fruits	1.5 ±1.6
Excluding 100% juice	0.9 ±1.3
Legumes	0.2 ±0.4
Whole grains	1.1 ±1.3
Refined grains	4.6 ±3.1
Sugar-sweetened beverages	0.7 ±0.9
Excluding flavored milk	0.5 ±0.7
Dairy	1.7 ±1.2
Excluding flavored milk	1.5 ±1.2
Meat	3.7 ±2.3

[a]All values are n (%) or mean ± standard deviation. Diet data reflects the average of two days. [b]Servings per day.

Table 3. Adiposity measurements and metabolic parameters between breakfast consumption groups[a,b]

	Total (n)	SKIPPER	INTERMITTENT	REGULAR	P-value
Adiposity and physical measurements					
Sample size	671	114	249	308	
Prevalence of OW/OB[c] (%)		46.5	51.0	47.7	0.65
Waist circumference (cm)		71.8 ±12.1	72.4 ±12.1	70.5 ±12.3	0.09
Total body fat (%)		26.3 ±8.3	26.6 ±8.8	26.2 ±9.5	0.39
BMI z-score		0.9 ±1.0	0.9 ±1.1	0.8 ±1.2	0.12
BMI percentile (%)		73.5 ±26.3	73.0 ±27.9	69.8 ±29.9	0.14
Systolic blood pressure (mmHg)		103.1 ±10.9	103.5 ±10.9	102.5 ±11.7	0.58
Diastolic blood pressure (mmHg)		67.9 ±10.3	67.6 ±8.9	67.4 ±9.8	0.72
Metabolic parameters[d]					
Sample size	347	66	129	152	
Fasting glucose (mg/dL)		91.3 ±8.6	90.8 ±10.5	91.1 ±8.5	0.88
Insulin (µIU/mL)		17.6 ±12.0	17.8 ±15.2	14.7 ±11.7	0.72
Sample size	345	66	129	150	
Cholesterol (mg/dL)		151.7 ±26.6	153.5 ±24.3	152.8 ±25.3	0.95
HDL (mg/dL)		47.1 ±9.3	47.0 ±9.8	48.6 ±10.2	0.94
Non-HDL (mg/dL)		104.7 ±25.5	106.5 ±23.0	104.3 ±23.3	0.90
LDL (mg/dL)		84.8 ±20.8	88.5 ±20.6	85.8 ±20.7	0.53
Triglycerides (mg/dL)		99.3 ±52.3	90.7 ±38.3	92.1 ±42.9	0.37
Sample size	241	51	84	106	
HbA1c (%)		5.2 ±0.3	5.3 ±0.5	5.2 ±0.3	0.48

Abbreviations: HbA1c, glycolated hemoglobin A1c; HDL, high-density lipoprotein; LDL, low-density lipoprotein; OW, overweight; OB, obese; ANCOVA, analysis of covariance. [a]All values are mean ± standard deviation. [b]ANCOVA analysis assessed differences in waist circumference, total body fat, BMI z-score, BMI percentile, systolic blood pressure, diastolic blood pressure, fasting glucose, and HbA1c between breakfast consumption groups. [c]Pearson's chi-square test assessed differences in OW/OB prevalence between breakfast consumption groups. [d]Metabolic parameters were collected on a subsample. *A priori* covariates included: age, sex, race/ethnicity, free/reduced lunch status, energy, and BMI z-score (when glucose, insulin, cholesterol, triglycerides, and HbA1c were dependent variables).

Table 4. Dietary characteristics between breakfast consumption groups[a]

n = 671	SKIPPER[b]	INTERMITTENT[c]	REGULAR[d]	P-value	Bonferroni
Dietary variables[e]					
Eating occasions	2.8 ±0.7	3.3 ±0.7	3.6 ±0.7	< 0.001*	S vs. R, < 0.001 S vs. I, < 0.001 R vs. I, < 0.001
Healthy Eating Index-2015	51.6 ±13.3	52.4 ±11.7	55.7 ±12.3	0.003*	S vs. R, 0.009 R vs. I, 0.033
Total energy (kcal)	1473.3 ±553.6	1536.4 ±646.4	1363.3 ±419.6	<0.005*	R vs. I, 0.003
Carbohydrate (%)	44.8 ±8.5	48.9 ±8.2	52.1 ±8.6	< 0.001*	S vs. R, < 0.001 S vs. I, < 0.001 R vs. I, < 0.001
Protein (%)	15.3 ±3.8	15.8 ±3.8	16.9 ±3.8	< 0.001*	S vs. R, < 0.001 S vs. I, < 0.001 R vs. I, < 0.001
Fat (%)	35.0 ±6.5	33.7 ±7.0	32.3 ±6.9	< 0.001*	S vs. R, < 0.001 S vs. I, < 0.001 R vs. I, < 0.001
Total fiber (%)	3.4 ±1.3	3.3 ±1.1	3.6 ±1.3	0.037*	--
Soluble fiber (%)	1.0 ±0.4	1.1 ±0.4	1.2 ±0.4	< 0.001*	S vs. R, <0.001 R vs. I, 0.029
Insoluble fiber (%)	2.4 ±1.1	2.3 ±0.9	2.5 ±1.0	0.14	--
Total sugar (%)	16.7 ±7.3	20.3 ±8.3	22.6 ± 6.9	< 0.001*	S vs. R, < 0.001 S vs. I, < 0.001 R vs. I, 0.007
Added sugar (%)	8.6 ±5.7	10.6 ±6.3	10.2 ±5.4	<0.003*	S vs. R, 0.006 S vs. I, 0.003
Food/beverage servings[e]					
Vegetables					
Including 100% juice and potatoes	1.8 ±1.4	1.7 ±1.3	1.6 ±1.2	0.82	--
Excluding 100% juice	1.8 ±1.4	1.7 ±1.3	1.6 ±1.2	0.80	--
Excluding 100% juice and potatoes	1.6 ±1.4	1.5 ±1.2	1.5 ±1.2	0.50	--
Fruits					
Including 100% juice	1.3 ±1.3	1.5 ±1.9	1.7 ±1.4	< 0.001*	S vs. R, 0.003 R vs. I, 0.009
Excluding 100% juice	0.9 ±1.0	0.9 ±1.7	1.0 ±1.1	0.27	--
Legumes	0.3 ±0.6	0.2 ±0.4	0.2 ±0.4	0.06	--
Whole grains	1.0 ±1.6	1.1 ±1.4	1.1 ±1.0	< 0.003*	S vs. R, 0.002 S vs. I, 0.026
Refined grains	4.7 ±3.0	4.8 ±3.9	4.4 ±2.2	0.15	--
Sugar-sweetened beverages					
Including flavored milk	0.6 ±0.6	0.8 ±1.1	0.7 ±0.8	0.35	--
Excluding flavored milk	0.5 ±0.6	0.6 ±0.9	0.4 ±0.6	0.57	--
Dairy					
Including flavored milk	1.7 ±1.2	1.8 ±1.4	1.7 ±1.0	0.11	--
Excluding flavored milk	1.5 ±1.2	1.5 ±1.4	1.4 ±1.0	0.49	--
Meat	3.8 ±2.4	3.8 ±2.7	3.5 ±2.0	0.98	--

Abbreviations: ANCOVA, analysis of covariance; S, breakfast skipper; I; intermittent breakfast eater; R, regular breakfast consumer. [a]All values are mean ± standard deviation over the two days recorded. [b]n = 114. [c]n = 249. [d] n = 308. [e]ANCOVA analysis assessed differences in HEI-2015, energy, carbohydrate, protein, fat, fiber, sugar, and food/beverage servings per day between breakfast consumption groups. *A priori* covariates included: age, sex, race/ethnicity, free/reduced lunch status, BMI z-score, day of the week, and total energy. When macronutrient % was the dependent variable, energy was substituted with the complementary % macronutrients as covariates.

Table 5. Composition of breakfast between intermittent and regular consumers[a]			
n = 557	INTERMITTENT[b]	REGULAR[c]	P-value
Dietary variables[d]			
Total energy (kcal)	200.8 ±109.4	384.0 ±167.3	< 0.001*
Carbohydrate (%)	61.3 ±19.6	62.1 ±14.0	0.15
Protein (%)	12.8 ±5.2	13.4 ±4.1	0.001*
Fat (%)	27.7 ±15.8	26.5 ±11.3	0.22
Total fiber (%)	3.2 ±2.3	3.4 ±1.9	0.053
Soluble fiber (%)	1.1 ±1.0	1.2 ±0.8	0.17
Insoluble fiber (%)	2.1 ±1.8	2.2 ±1.4	0.041*
Total sugar (%)	31.7 ±17.3	32.6 ± 12.1	0.59
Added sugar (%)	15.7 ±13.5	14.3 ±8.6	0.034*
Food servings[d]			
Whole grains	0.3 ±0.5	0.5 ±0.6	< 0.001*
Refined grains	0.6 ±0.7	0.6 ±0.5	0.59

Abbreviations: ANCOVA, analysis of covariance. [a]All values are mean ± standard deviation over the two days recorded. [b]n = 249. [c]n = 308. [d]ANCOVA analysis assessed differences in energy, carbohydrate, protein, fat, fiber, sugar, and grains per day between intermittent and regular consumers. *A priori* covariates included: age, sex, race/ethnicity, free/reduced lunch status, BMI z-score, day of the week, and total energy. When breakfast macronutrient % was the dependent variable, energy was substituted with the complementary % macronutrients of breakfast as covariates.

Table 6. Composition of subsequent intake between breakfast consumption groups[a]

n = 671	SKIPPER[b]	INTERMITTENT[c]	REGULAR[d]	P-value	Bonferroni
Dietary variables[e]					
Total energy (kcal)	1378.0 ±510.3	1283.0 ±591.8	992.2 ±343.0	< 0.001*	S vs. R, < 0.001 R vs. I, < 0.001
Carbohydrate (%)	47.6 ±8.6	48.4 ±9.3	48.9 ±10.3	0.046*	--
Protein (%)	16.3 ±4.0	16.8 ±4.5	18.3 ±5.1	0.012*	S vs. R, 0.021
Fat (%)	37.2 ±6.8	35.9 ±7.6	34.0 ±7.8	0.15	--
Total fiber (%)	3.6 ±1.4	3.5 ±1.3	3.8 ±1.6	0.14	--
Soluble fiber (%)	1.1 ±0.5	1.1 ±0.4	1.2 ±0.5	0.10	--
Insoluble fiber (%)	2.5 ±1.2	2.4 ±1.1	2.6 ±1.3	0.21	--
Total sugar (%)	17.6 ±7.5	19.1 ±9.2	19.2 ± 8.2	0.31	--
Added sugar (%)	9.1 ±5.9	10.1 ±7.6	8.7 ±6.2	< 0.003*	S vs. R, < 0.02 R vs. I, 0.003
Food servings[e]					
Whole grains	1.0 ±1.6	0.9 ±1.2	0.6 ±0.8	0.039*	--
Refined grains	2.4 ±1.5	2.1 ±2.1	1.6 ±0.9	< 0.001*	S vs. R, < 0.001 S vs. I, 0.019 R vs. I, 0.018

Abbreviations: ANCOVA, analysis of covariance; S, breakfast skipper; I; intermittent breakfast eater; R, regular breakfast consumer. [a]All values are mean ± standard deviation over the two days recorded.[b]n = 114 [c]n = 249. [d]n = 308. [e]ANCOVA analysis assessed differences in energy, carbohydrate, protein, fat, fiber, sugar, and grains per day between breakfast consumption groups. *A priori* covariates included: age, sex, race/ethnicity, free/reduced lunch status, BMI z-score, day of the week, and breakfast energy. When subsequent macronutrient % was the dependent variable, breakfast energy was substituted with the complementary % macronutrients of subsequent intake as covariates.

Chapter 3: Conclusions and Future Directions

The results presented serve as the foundation for other work I wish to pursue moving forward. This study showed breakfast consumption did not elicit a positive response on adiposity or metabolic outcomes in predominately low-income Hispanic elementary school-aged children. However, negative dietary habits were observed in breakfast consumers, such as higher intake of total and added sugars, potentially contributing to the null associations observed. The analyses in this study examined breakfast consumption on health outcomes, breakfast composition, and subsequent intake. Future analyses to examine include whether breakfast composition or quality and subsequent intake mediate the null associations that were observed.

In addition, associations of breakfast consumption on location of where breakfast is consumed and whether location mediates these associations should be examined. All of the schools included in this study were Title I schools, and low-income children may rely more on school programs to provide majority of their food consumed throughout the day. As a result, the School Breakfast and Lunch Programs play a prominent role in what is being consumed at school, and the current guidelines have no restrictions on consumption of flavored milk or juice products and serves high-carbohydrate breakfasts with no protein requirement.

Lastly, the TX Sprouts intervention showed an increase in fruit and vegetable consumption compared to the control schools. The intervention included curriculum encouraging breakfast consumption, teaching children the parts of a healthy breakfast, with one component highlighting the benefits of eating fruit. Fruit is a common component of breakfast; therefore, examining if breakfast consumption mediated the increase in fruit and vegetable consumption would prove breakfast to be an effective dietary behavior to target in future interventions and policy. Analyzing the interventional effect on breakfast consumption would further contribute to these findings, particularly if breakfast consumption increased over the course of the intervention.

The effort put forth in my research thus far has confirmed my desire to continue work in childhood obesity epidemiology and prevention. While this has not changed, my experiences in the graduate program at the University of Texas at Austin have shown me that I would like to serve in a role that directly impacts a large number of people. As simplistic a conclusion that may seem, I have learned the different capacities in which I can achieve that goal. For instance, my time in this program has fostered my interest in statistical analysis, something in which I had very minimal experience prior to this program. My enjoyment for getting lost in the numbers developed from obtaining my first set of significant results in a statistical methods course during my first semester. The excitement of developing a hypothesis in which the data supported has motivated me to combine my interest in data analysis and childhood obesity epidemiology and prevention. I have fostered this interest through taking additional statistical coursework, composing nearly one-third of my credits earned, which has taught me the use of several software packages including Stata, SAS, and SPSS.

Most of my experiences in data analysis have pertained to that of dietary recall data, which is structured in a “long” format. Working with data in this manner has preluded my experiences in data syntax development, giving me multiple skills in data manipulation and coding. From these experiences, I have not only learned additional coding skills across multiple platforms, but I have also been able to put these skills to use in a project involving the conversion of data from the Nutrition Data System for Research to the NOVA Classification System, which serves to classify individual food components from unprocessed to ultra-processed. As I continue my efforts into the PhD program, I hope to learn R software and take coursework pertaining to structural equation and mixed modeling to pursue my future analysis endeavors. To prepare myself for a career in this area, I aim to obtain the portfolio in applied statistical modeling as offered by the University of Texas at Austin.

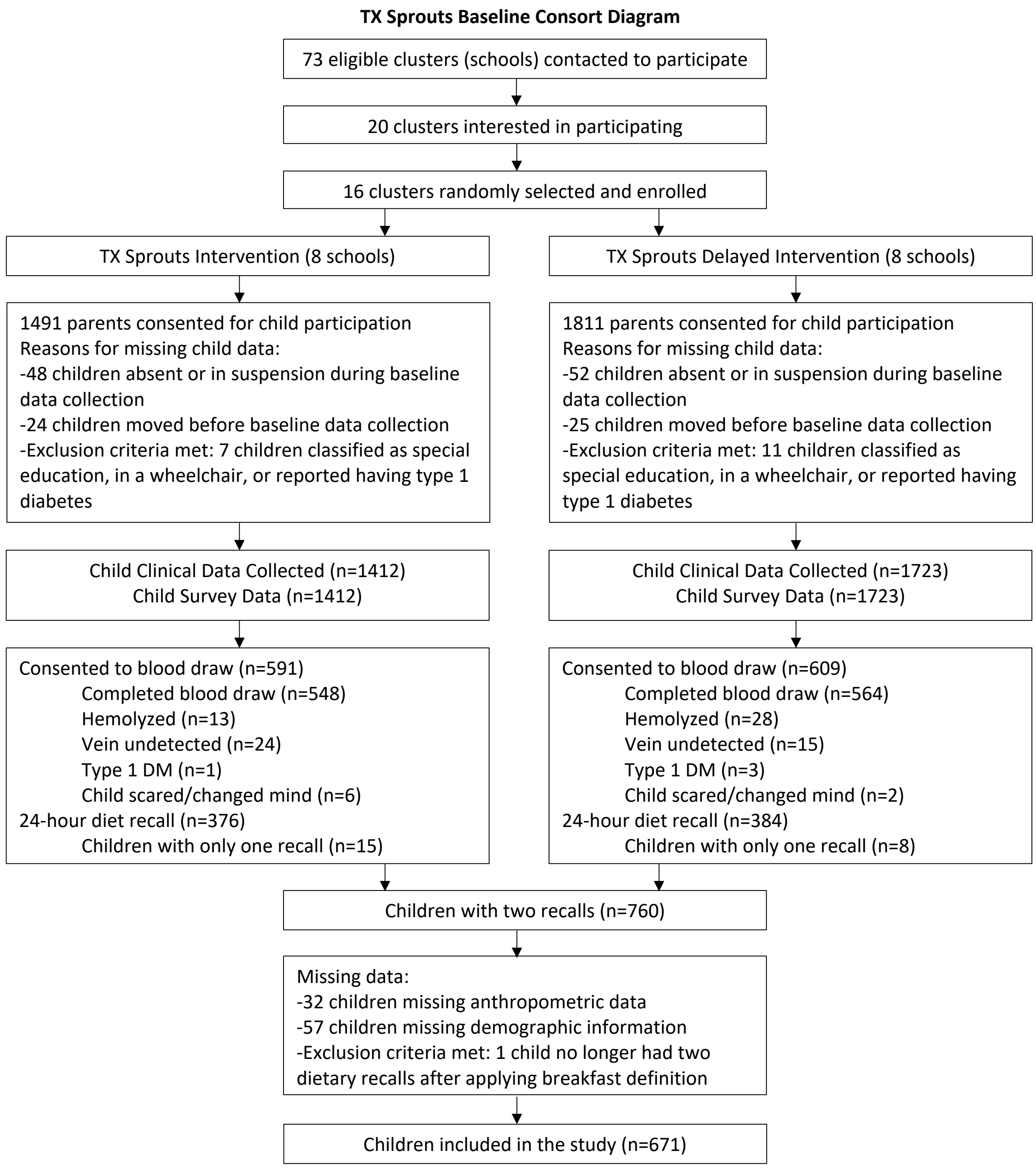
While my interest in data analysis began during the first semester of this program, my interest in pursuing policy work did not develop until this past year. Through working on my thesis, I began to understand how policy can have a tremendous impact on health outcomes in any given population, primarily through the lens of the School Breakfast Program and how it relates to my work thus far. From preliminary analyses of work outside the scope of my thesis, data shows higher consumption of ultra-processed foods at school compared to home. The work I have presented at The Obesity Society (2019) and will present at the American Society for Nutrition (2020) and American Public Health Association (2020) suggest that policy needs to reassess its current standards to further benefit low-income children. In 2018, the National School Lunch Program served nearly 30 million children daily while the School Breakfast program served nearly 15 million children daily. From these programs alone, one can see the massive impact policy can have on any given population.

With these interests in mind, I have been admitted into the PhD program and will begin my next study focusing on breakfast consumption and its associations with location of breakfast on health outcomes this summer. Furthermore, as there are currently no set guidelines for metabolic syndrome in children, I would like to not only study associations on prevalence of metabolic syndrome in children through comparison of multiple guidelines, but also examine if breakfast consumption serves a role in preventing metabolic syndrome and/or its individual risk factors. My current role as a graduate student researcher has earned me membership into the Central Health Equity Policy Council in Austin, TX, exposing me to policy work and managing a campaign. From the experiences and skills gained over the past two years, I wish to continue pursuing research in childhood obesity epidemiology and prevention while marrying my results to policy in an effort to improve health outcomes for children.

Appendix

Figures

Figure 1. Consort Diagram



Bibliography

1. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of Obesity Among Adults and Youth: United States, 2015-2016. NCHS Data Brief. 2017 Oct:1-8.
2. Hales CM, Fryar CD, Carroll MD, Freedman DS, Ogden CL. Trends in Obesity and Severe Obesity Prevalence in US Youth and Adults by Sex and Age, 2007-2008 to 2015-2016. JAMA. 2018 Apr 24;319:1723-5.
3. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults--The Evidence Report. National Institutes of Health. Obes Res. 1998 Sep;6 Suppl 2:51S-209S.
4. Prevention CfDCa. National Diabetes Statistics Report, 2020. Atlanta, GA: Centers for Disease Control and Prevention, US Department of Health and Human Services; 2020.
5. DeBoer MD, Dong L, Gurka MJ. Racial/ethnic and sex differences in the ability of metabolic syndrome criteria to predict elevations in fasting insulin levels in adolescents. J Pediatr. 2011 Dec;159:975-81 e3.
6. Rosner B, Cook NR, Daniels S, Falkner B. Childhood Blood Pressure Trends and Risk Factors for High Blood Pressure: The NHANES Experience 1988-2008. Hypertension. 2013 Oct 14.
7. Jackson SL, Zhang Z, Wiltz JL, Loustalot F, Ritchey MD, Goodman AB, Yang Q. Hypertension Among Youths—United States, 2001–2016. American Journal of Transplantation. 2018;18:2356-60.
8. Kit BK, Kuklina E, Carroll MD, Ostchega Y, Freedman DS, Ogden CL. Prevalence of and trends in dyslipidemia and blood pressure among US children and adolescents, 1999-2012. JAMA Pediatr. 2015 Mar;169:272-9.
9. Mayer-Davis EJ, Ma B, Lawson A, D'Agostino RB, Jr., Liese AD, Bell RA, Dabelea D, Dolan L, Pettitt DJ, et al. Cardiovascular disease risk factors in youth with type 1 and type 2 diabetes: implications of a factor analysis of clustering. Metab Syndr Relat Disord. 2009 Apr;7:89-95.
10. Rodriguez BL, Dabelea D, Liese AD, Fujimoto W, Waitzfelder B, Liu L, Bell R, Talton J, Snively BM, et al. Prevalence and correlates of elevated blood pressure in youth with diabetes mellitus: the SEARCH for diabetes in youth study. J Pediatr. 2010 Aug;157:245-51 e1.
11. Nguyen D, Kit B, Carroll M. Abnormal Cholesterol Among Children and Adolescents in the United States, 2011-2014. NCHS Data Brief. 2015 Dec:1-8.
12. Breslin WL, Johnston CA, Strohacker K, Carpenter KC, Davidson TR, Moreno JP, Foreyt JP, McFarlin BK. Obese Mexican American children have elevated MCP-1, TNF-alpha, monocyte concentration, and dyslipidemia. Pediatrics. 2012 May;129:e1180-6.
13. Cook S, Weitzman M, Auinger P, Nguyen M, Dietz WH. Prevalence of a metabolic syndrome phenotype in adolescents: findings from the third National Health and Nutrition Examination Survey, 1988-1994. Arch Pediatr Adolesc Med. 2003 Aug;157:821-7.
14. Cruz ML, Weigensberg MJ, Huang TT, Ball G, Shaibi GQ, Goran MI. The metabolic syndrome in overweight Hispanic youth and the role of insulin sensitivity. J Clin Endocrinol Metab. 2004 Jan;89:108-13.
15. de Ferranti SD, Gauvreau K, Ludwig DS, Neufeld EJ, Newburger JW, Rifai N. Prevalence of the metabolic syndrome in American adolescents: findings from the Third National Health and Nutrition Examination Survey. Circulation. 2004 Oct 19;110:2494-7.

16. Weiss R, Dziura J, Burgert TS, Tamborlane WV, Taksali SE, Yeckel CW, Allen K, Lopes M, Savoye M, et al. Obesity and the metabolic syndrome in children and adolescents. N Engl J Med. 2004 Jun 3;350:2362-74.
17. Alberti KG, Zimmet P, Shaw J, Group IDFETFC. The metabolic syndrome--a new worldwide definition. Lancet. 2005 Sep 24-30;366:1059-62.
18. Ford ES, Ajani UA, Mokdad AH, National H, Nutrition E. The metabolic syndrome and concentrations of C-reactive protein among U.S. youth. Diabetes Care. 2005 Apr;28:878-81.
19. Deboer MD. Ethnicity, obesity and the metabolic syndrome: implications on assessing risk and targeting intervention. Expert Rev Endocrinol Metab. 2011 Mar;6:279-89.
20. Morrison JA, Friedman LA, Wang P, Glueck CJ. Metabolic syndrome in childhood predicts adult metabolic syndrome and type 2 diabetes mellitus 25 to 30 years later. J Pediatr. 2008 Feb;152:201-6.
21. Clark AM, DesMeules M, Luo W, Duncan AS, Wielgosz A. Socioeconomic status and cardiovascular disease: risks and implications for care. Nat Rev Cardiol. 2009 Nov;6:712-22.
22. Puolakka E, Pahkala K, Laitinen TT, Magnussen CG, Hutri-Kahonen N, Tossavainen P, Jokinen E, Sabin MA, Laitinen T, et al. Childhood Socioeconomic Status in Predicting Metabolic Syndrome and Glucose Abnormalities in Adulthood: The Cardiovascular Risk in Young Finns Study. Diabetes Care. 2016 Dec;39:2311-7.
23. Kapral N, Miller SE, Scharf RJ, Gurka MJ, DeBoer MD. Associations between birthweight and overweight and obesity in school-age children. Pediatr Obes. 2018 Jun;13:333-41.
24. Seyednasrollah F, Makela J, Pitkanen N, Juonala M, Hutri-Kahonen N, Lehtimaki T, Viikari J, Kelly T, Li C, et al. Prediction of Adulthood Obesity Using Genetic and Childhood Clinical Risk Factors in the Cardiovascular Risk in Young Finns Study. Circ Cardiovasc Genet. 2017 Jun;10.
25. Garmy P, Clausson EK, Nyberg P, Jakobsson U. Insufficient Sleep Is Associated with Obesity and Excessive Screen Time Amongst Ten-Year-Old Children in Sweden. J Pediatr Nurs. 2018 Mar - Apr;39:e1-e5.
26. Laguna M, Ruiz JR, Gallardo C, Garcia-Pastor T, Lara MT, Aznar S. Obesity and physical activity patterns in children and adolescents. J Paediatr Child Health. 2013 Nov;49:942-9.
27. LeBlanc AG, Katzmarzyk PT, Barreira TV, Broyles ST, Chaput JP, Church TS, Fogelholm M, Harrington DM, Hu G, et al. Correlates of Total Sedentary Time and Screen Time in 9-11 Year-Old Children around the World: The International Study of Childhood Obesity, Lifestyle and the Environment. PLoS One. 2015;10:e0129622.
28. Wang L, Collins C, Ratliff M, Xie B, Wang Y. Breastfeeding Reduces Childhood Obesity Risks. Child Obes. 2017 Jun;13:197-204.
29. Taveras EM, Gillman MW, Kleinman KP, Rich-Edwards JW, Rifas-Shiman SL. Reducing racial/ethnic disparities in childhood obesity: the role of early life risk factors. JAMA Pediatr. 2013 Aug 1;167:731-8.
30. Chung A, Backholer K, Wong E, Palermo C, Keating C, Peeters A. Trends in child and adolescent obesity prevalence in economically advanced countries according to socioeconomic position: a systematic review. Obes Rev. 2016 Mar;17:276-95.
31. Jones A. Parental Socioeconomic Instability and Child Obesity. Biodemography Soc Biol. 2018 Jan-Mar;64:15-29.

32. Moraeus L, Lissner L, Yngve A, Poortvliet E, Al-Ansari U, Sjoberg A. Multi-level influences on childhood obesity in Sweden: societal factors, parental determinants and child's lifestyle. Int J Obes (Lond). 2012 Jul;36:969-76.
33. Coleman-Jensen A, Rabbitt MP, Gregory CA, Singh A. Household Food Security in the United States in 2018: U.S. Department of Agriculture, Economic Research Service; 2019.
34. Papas MA, Trabulsi JC, Dahl A, Dominick G. Food Insecurity Increases the Odds of Obesity Among Young Hispanic Children. J Immigr Minor Health. 2016 Oct;18:1046-52.
35. Potochnick S, Perreira KM, Bravin JI, Castaneda SF, Daviglus ML, Gallo LC, Isasi CR. Food Insecurity Among Hispanic/Latino Youth: Who Is at Risk and What Are the Health Correlates? J Adolesc Health. 2019 May;64:631-9.
36. van Kleef E, Vingerhoeds MH, Vrijhof M, van Trijp HCM. Breakfast barriers and opportunities for children living in a Dutch disadvantaged neighbourhood. Appetite. 2016 Dec 1;107:372-82.
37. Darling KE, Fahrenkamp AJ, Wilson SM, D'Auria AL, Sato AF. Physical and mental health outcomes associated with prior food insecurity among young adults. J Health Psychol. 2017 Apr;22:572-81.
38. Seligman HK, Schillinger D. Hunger and socioeconomic disparities in chronic disease. N Engl J Med. 2010 Jul 1;363:6-9.
39. Fram MS, Ritchie LD, Rosen N, Frongillo EA. Child experience of food insecurity is associated with child diet and physical activity. J Nutr. 2015 Mar;145:499-504.
40. Landry MJ, van den Berg AE, Asigbee FM, Vandyousefi S, Ghaddar R, Davis JN. Child-Report of Food Insecurity Is Associated with Diet Quality in Children. Nutrients. 2019 Jul 12;11.
41. Belachew T, Lindstrom D, Gebremariam A, Hogan D, Lachat C, Huybregts L, Kolsteren P. Food insecurity, food based coping strategies and suboptimal dietary practices of adolescents in Jimma zone Southwest Ethiopia. PLoS One. 2013;8:e57643.
42. Nackers LM, Appelhans BM. Food insecurity is linked to a food environment promoting obesity in households with children. J Nutr Educ Behav. 2013 Nov-Dec;45:780-4.
43. Monzani A, Ricotti R, Caputo M, Solito A, Archero F, Bellone S, Prodam F. A Systematic Review of the Association of Skipping Breakfast with Weight and Cardiometabolic Risk Factors in Children and Adolescents. What Should We Better Investigate in the Future? Nutrients. 2019 Feb 13;11.
44. Horikawa C, Kodama S, Yachi Y, Heianza Y, Hirasawa R, Ibe Y, Saito K, Shimano H, Yamada N, Sone H. Skipping breakfast and prevalence of overweight and obesity in Asian and Pacific regions: a meta-analysis. Prev Med. 2011 Oct;53:260-7.
45. Archero F, Ricotti R, Solito A, Carrera D, Civello F, Di Bella R, Bellone S, Prodam F. Adherence to the Mediterranean Diet among School Children and Adolescents Living in Northern Italy and Unhealthy Food Behaviors Associated to Overweight. Nutrients. 2018 Sep 18;10.
46. Fayet-Moore F, Kim J, Sritharan N, Petocz P. Impact of Breakfast Skipping and Breakfast Choice on the Nutrient Intake and Body Mass Index of Australian Children. Nutrients. 2016 Aug 10;8.
47. Gotthelf SJ, Tempestti CP. Breakfast, nutritional status, and socioeconomic outcome measures among primary school students from the City of Salta: A cross-sectional study. Arch Argent Pediatr. 2017 Oct 1;115:424-31.

48. Ho CY, Huang YC, Lo YT, Wahlqvist ML, Lee MS. Breakfast is associated with the metabolic syndrome and school performance among Taiwanese children. Res Dev Disabil. 2015 Aug-Sep;43-44:179-88.
49. Nilsen BB, Yngve A, Monteagudo C, Tellstrom R, Scander H, Werner B. Reported habitual intake of breakfast and selected foods in relation to overweight status among seven- to nine-year-old Swedish children. Scand J Public Health. 2017 Dec;45:886-94.
50. O'Neil CE, Nicklas TA, Fulgoni VL, 3rd. Nutrient Intake, Diet Quality, and Weight Measures in Breakfast Patterns Consumed by Children Compared with Breakfast Skippers: NHANES 2001-2008. AIMS Public Health. 2015;2:441-68.
51. Smetanina N, Albaviciute E, Babinska V, Karinauskiene L, Albertsson-Wikland K, Petrauskiene A, Verkauskiene R. Prevalence of overweight/obesity in relation to dietary habits and lifestyle among 7-17 years old children and adolescents in Lithuania. BMC Public Health. 2015 Oct 1;15:1001.
52. Smith KJ, Breslin MC, McNaughton SA, Gall SL, Blizzard L, Venn AJ. Skipping breakfast among Australian children and adolescents; findings from the 2011-12 National Nutrition and Physical Activity Survey. Aust N Z J Public Health. 2017 Dec;41:572-8.
53. Tee ES, Nurliyana AR, Norimah AK, Mohamed H, Tan SY, Appukutty M, Hopkins S, Thielecke F, Ong MK, et al. Breakfast consumption among Malaysian primary and secondary school children and relationship with body weight status - Findings from the MyBreakfast Study. Asia Pac J Clin Nutr. 2018;27:421-32.
54. Zakrzewski JK, Gillison FB, Cumming S, Church TS, Katzmarzyk PT, Broyles ST, Champagne CM, Chaput JP, Denstel KD, et al. Associations between breakfast frequency and adiposity indicators in children from 12 countries. Int J Obes Suppl. 2015 Dec;5:S80-8.
55. Cho S, Dietrich M, Brown CJ, Clark CA, Block G. The effect of breakfast type on total daily energy intake and body mass index: results from the Third National Health and Nutrition Examination Survey (NHANES III). J Am Coll Nutr. 2003 Aug;22:296-302.
56. Van Lippevelde W, Te Velde SJ, Verloigne M, Van Stralen MM, De Bourdeaudhuij I, Manios Y, Bere E, Vik FN, Jan N, et al. Associations between family-related factors, breakfast consumption and BMI among 10- to 12-year-old European children: the cross-sectional ENERGY-study. PLoS One. 2013;8:e79550.
57. Shafiee G, Kelishadi R, Qorbani M, Motlagh ME, Taheri M, Ardalan G, Taslimi M, Poursafa P, Heshmat R, Larijani B. Association of breakfast intake with cardiometabolic risk factors. J Pediatr (Rio J). 2013 Nov-Dec;89:575-82.
58. Smith KJ, Gall SL, McNaughton SA, Blizzard L, Dwyer T, Venn AJ. Skipping breakfast: longitudinal associations with cardiometabolic risk factors in the Childhood Determinants of Adult Health Study. Am J Clin Nutr. 2010 Dec;92:1316-25.
59. Deshmukh-Taskar P, Nicklas TA, Radcliffe JD, O'Neil CE, Liu Y. The relationship of breakfast skipping and type of breakfast consumed with overweight/obesity, abdominal obesity, other cardiometabolic risk factors and the metabolic syndrome in young adults. The National Health and Nutrition Examination Survey (NHANES): 1999-2006. Public Health Nutr. 2013 Nov;16:2073-82.
60. Monzani A, Rapa A, Fuiano N, Diddi G, Prodam F, Bellone S, Bona G. Metabolic syndrome is strictly associated with parental obesity beginning from childhood. Clin Endocrinol (Oxf). 2014 Jul;81:45-51.

61. Osawa H, Sugihara N, Ukiya T, Ishizuka Y, Birkhed D, Hasegawa M, Matsukubo T. Metabolic Syndrome, Lifestyle, and Dental Caries in Japanese School Children. Bull Tokyo Dent Coll. 2015;56:233-41.
62. Lepicard EM, Maillot M, Vieux F, Viltard M, Bonnet F. Quantitative and qualitative analysis of breakfast nutritional composition in French schoolchildren aged 9-11 years. J Hum Nutr Diet. 2017 Apr;30:151-8.
63. Deshmukh-Taskar PR, Nicklas TA, O'Neil CE, Keast DR, Radcliffe JD, Cho S. The relationship of breakfast skipping and type of breakfast consumption with nutrient intake and weight status in children and adolescents: the National Health and Nutrition Examination Survey 1999-2006. J Am Diet Assoc. 2010 Jun;110:869-78.
64. Nicklas TA, O'Neil C, Fulgoni V, 3rd. Flavored Milk Consumers Drank More Milk and Had a Higher Prevalence of Meeting Calcium Recommendation Than Nonconsumers. J Sch Health. 2017 Sep;87:650-7.
65. Coulthard JD, Palla L, Pot GK. Breakfast consumption and nutrient intakes in 4-18-year-olds: UK National Diet and Nutrition Survey Rolling Programme (2008-2012). Br J Nutr. 2017 Aug;118:280-90.
66. Fayet-Moore F, McConnell A, Tuck K, Petocz P. Breakfast and Breakfast Cereal Choice and Its Impact on Nutrient and Sugar Intakes and Anthropometric Measures among a Nationally Representative Sample of Australian Children and Adolescents. Nutrients. 2017 Sep 21;9.
67. Kupers LK, de Pijper JJ, Sauer PJ, Stolk RP, Corpeleijn E. Skipping breakfast and overweight in 2- and 5-year-old Dutch children-the GECKO Drenthe cohort. Int J Obes (Lond). 2014 Apr;38:569-71.
68. Kuriyan R, Thomas T, Sumithra S, Lokesh DP, Sheth NR, Joy R, Bhat S, Kurpad AV. Potential factors related to waist circumference in urban South Indian children. Indian Pediatr. 2012 Feb;49:124-8.
69. Polonsky HM, Bauer KW, Fisher JO, Davey A, Sherman S, Abel ML, Hanlon A, Ruth KJ, Dale LC, Foster GD. Effect of a Breakfast in the Classroom Initiative on Obesity in Urban School-aged Children: A Cluster Randomized Clinical Trial. JAMA Pediatr. 2019 Apr 1;173:326-33.
70. Drewnowski A, Rehm CD, Vieux F. Breakfast in the United States: Food and Nutrient Intakes in Relation to Diet Quality in National Health and Examination Survey 2011(-)2014. A Study from the International Breakfast Research Initiative. Nutrients. 2018 Sep 1;10.
71. Barr SI, Vatanparast H, Smith J. Breakfast in Canada: Prevalence of Consumption, Contribution to Nutrient and Food Group Intakes, and Variability across Tertiles of Daily Diet Quality. A Study from the International Breakfast Research Initiative. Nutrients. 2018 Jul 27;10.
72. Harland JI, Garton LE. Whole-grain intake as a marker of healthy body weight and adiposity. Public Health Nutr. 2008 Jun;11:554-63.
73. Afeiche MC, Taillie LS, Hopkins S, Eldridge AL, Popkin BM. Breakfast Dietary Patterns among Mexican Children Are Related to Total-Day Diet Quality. J Nutr. 2017 Mar;147:404-12.
74. Gaal S, Kerr MA, Ward M, McNulty H, Livingstone MBE. Breakfast Consumption in the UK: Patterns, Nutrient Intake and Diet Quality. A Study from the International Breakfast Research Initiative Group. Nutrients. 2018 Jul 30;10.
75. Kral TV, Whiteford LM, Heo M, Faith MS. Effects of eating breakfast compared with skipping breakfast on ratings of appetite and intake at subsequent meals in 8- to 10-y-old children. Am J Clin Nutr. 2011 Feb;93:284-91.

76. Leidy HJ, Hoertel HA, Douglas SM, Higgins KA, Shafer RS. A high-protein breakfast prevents body fat gain, through reductions in daily intake and hunger, in "Breakfast skipping" adolescents. Obesity (Silver Spring). 2015 Sep;23:1761-4.
77. Kung B, Anderson GH, Pare S, Tucker AJ, Vien S, Wright AJ, Goff HD. Effect of milk protein intake and casein-to-whey ratio in breakfast meals on postprandial glucose, satiety ratings, and subsequent meal intake. J Dairy Sci. 2018 Oct;101:8688-701.
78. Jakubowicz D, Wainstein J, Landau Z, Ahren B, Barnea M, Bar-Dayan Y, Froy O. High-energy breakfast based on whey protein reduces body weight, postprandial glycemia and HbA1C in Type 2 diabetes. J Nutr Biochem. 2017 Nov;49:1-7.
79. Leidy HJ, Ortinau LC, Douglas SM, Hoertel HA. Beneficial effects of a higher-protein breakfast on the appetitive, hormonal, and neural signals controlling energy intake regulation in overweight/obese, "breakfast-skipping," late-adolescent girls. Am J Clin Nutr. 2013 Apr;97:677-88.
80. Fallaize R, Wilson L, Gray J, Morgan LM, Griffin BA. Variation in the effects of three different breakfast meals on subjective satiety and subsequent intake of energy at lunch and evening meal. Eur J Nutr. 2013 Jun;52:1353-9.
81. Laverty AA, Magee L, Monteiro CA, Saxena S, Millett C. Sugar and artificially sweetened beverage consumption and adiposity changes: National longitudinal study. Int J Behav Nutr Phys Act. 2015 Oct 26;12:137.
82. Seferidi P, Millett C, Laverty AA. Sweetened beverage intake in association to energy and sugar consumption and cardiometabolic markers in children. Pediatr Obes. 2018 Apr;13:195-203.
83. Bartfeld J, Kim M. Participation in the School Breakfast Program: new evidence from the ECLS-K. Soc Serv Rev. 2010;84:541-62.
84. Arteaga I, Heflin C. Participation in the National School Lunch Program and food security: An analysis of transitions into kindergarten. Children and Youth Services Review. 2014;47:224-30.
85. Gundersen C, Kreider B, Pepper J. The impact of the National School Lunch Program on child health: A nonparametric bounds analysis. Journal of Econometrics. 2012;166:79-91.
86. Bartfeld JS, Ahn HM. The School Breakfast Program strengthens household food security among low-income households with elementary school children. J Nutr. 2011 Mar;141:470-5.
87. Clark MA, Fox MK. Nutritional quality of the diets of US public school children and the role of the school meal programs. J Am Diet Assoc. 2009 Feb;109:S44-56.
88. Affenito SG, Thompson D, Dorazio A, Albertson AM, Loew A, Holschuh NM. Ready-to-eat cereal consumption and the School Breakfast Program: relationship to nutrient intake and weight. J Sch Health. 2013 Jan;83:28-35.
89. Robinson-O'Brien R, Burgess-Champoux T, Haines J, Hannan PJ, Neumark-Sztainer D. Associations between school meals offered through the National School Lunch Program and the School Breakfast Program and fruit and vegetable intake among ethnically diverse, low-income children. J Sch Health. 2010 Oct;80:487-92.
90. Crepinsek MK, Gordon AR, McKinney PM, Condon EM, Wilson A. Meals offered and served in US public schools: do they meet nutrient standards? J Am Diet Assoc. 2009 Feb;109:S31-43.

91. Gleason P, Suitor C. Children's diets in the mid-1990s: dietary intake and its relationship with school meal participation: Mathematica Policy Research; 2001.
92. Services USDoAaUSDoHaH. Dietary Guidelines for Americans, 2015-2020. 8th ed: Washington, DC: U.S. Government Printing Office; 2015.
93. United States Department of Agriculture FaNS. Final Rule: Child Nutrition Program Flexibilities for Milk, Whole Grains, and Sodium Requirements. 2018.
94. Gibney MJ, Barr SI, Bellisle F, Drewnowski A, Fagt S, Livingstone B, Masset G, Varela Moreiras G, Moreno LA, et al. Breakfast in Human Nutrition: The International Breakfast Research Initiative. Nutrients. 2018 May 1;10.
95. Dwyer JT, Evans M, Stone EJ, Feldman HA, Lytle L, Hoelscher D, Johnson C, Zive M, Yang M, et al. Adolescents' eating patterns influence their nutrient intakes. J Am Diet Assoc. 2001 Jul;101:798-802.
96. Murata M. Secular trends in growth and changes in eating patterns of Japanese children. Am J Clin Nutr. 2000 Nov;72:1379S-83S.
97. Shaw ME. Adolescent breakfast skipping: an Australian study. Adolescence. 1998 Winter;33:851-61.
98. Overby NC, Margeirsdottir HD, Brunborg C, Dahl-Jorgensen K, Andersen LF, Norwegian Study Group for Childhood D. Sweets, snacking habits, and skipping meals in children and adolescents on intensive insulin treatment. Pediatr Diabetes. 2008 Aug;9:393-400.
99. Rodrigues PRM, Luiz RR, Monteiro LS, Ferreira MG, Goncalves-Silva RMV, Pereira RA. Adolescents' unhealthy eating habits are associated with meal skipping. Nutrition. 2017 Oct;42:114-20 e1.
100. Ramsay SA, Bloch TD, Marriage B, Shriver LH, Spees CK, Taylor CA. Skipping breakfast is associated with lower diet quality in young US children. Eur J Clin Nutr. 2018 Apr;72:548-56.
101. Dykstra H, Davey A, Fisher JO, Polonsky H, Sherman S, Abel ML, Dale LC, Foster GD, Bauer KW. Breakfast-Skipping and Selecting Low-Nutritional-Quality Foods for Breakfast Are Common among Low-Income Urban Children, Regardless of Food Security Status. J Nutr. 2016 Mar;146:630-6.
102. Liu Y, Tooze JA, Zhang Y, Leidy HJ, Bailey RL, Wright B, Ma M, Stluka S, Remley DT, et al. Breakfast Consumption Is Positively Associated with Usual Nutrient Intakes among Food Pantry Clients Living in Rural Communities. J Nutr. 2020 Mar 1;150:546-53.
103. Bauer LB, Reynolds LJ, Douglas SM, Kearney ML, Hoertel HA, Shafer RS, Thyfault JP, Leidy HJ. A pilot study examining the effects of consuming a high-protein vs normal-protein breakfast on free-living glycemic control in overweight/obese 'breakfast skipping' adolescents. Int J Obes (Lond). 2015 Sep;39:1421-4.
104. Currie CZ, C.; Morgan, A.; Currie, D.; de Looze, M.; Roberts, C.; Samdal, O.; Smith, O.R.F.; Barnekow, V. (Eds.). Social Determinants of Health and Well-Being among Young People. Health Behaviour in School-Aged Children (HBSC) Study: International Report from the 2009/2010 Survey. 2012;6.
105. Davis J, Nikah K, Asigbee FM, Landry MJ, Vandyousefi S, Ghaddar R, Hoover A, Jeans M, Pont SJ, et al. Design and participant characteristics of TX sprouts: A school-based cluster randomized gardening, nutrition, and cooking intervention. Contemp Clin Trials. 2019 Aug 23;85:105834.
106. Centers for Disease Control and Prevention. Anthropometry Procedures Manual. 2007.

107. Centers for Disease Control and Prevention. Clinical Growth Charts. 2000.
108. American Diabetes A. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2014 Jan;37 Suppl 1:S81-90.
109. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem. 1972 Jun;18:499-502.
110. Burrows TL, Martin RJ, Collins CE. A systematic review of the validity of dietary assessment methods in children when compared with the method of doubly labeled water. J Am Diet Assoc. 2010 Oct;110:1501-10.
111. Feskanich D, Sielaff BH, Chong K, Buzzard IM. Computerized collection and analysis of dietary intake information. Comput Methods Programs Biomed. 1989 Sep;30:47-57.
112. National Cancer Institute DoCCPS. Developing the Healthy Eating Index. 2015.
113. Kirkpatrick SI, Reedy J, Krebs-Smith SM, Pannucci TE, Subar AF, Wilson MM, Lerman JL, Tooze JA. Applications of the Healthy Eating Index for Surveillance, Epidemiology, and Intervention Research: Considerations and Caveats. J Acad Nutr Diet. 2018 Sep;118:1603-21.
114. Krebs-Smith SM, Pannucci TE, Subar AF, Kirkpatrick SI, Lerman JL, Tooze JA, Wilson MM, Reedy J. Update of the Healthy Eating Index: HEI-2015. J Acad Nutr Diet. 2018 Sep;118:1591-602.
115. Reedy J, Lerman JL, Krebs-Smith SM, Kirkpatrick SI, Pannucci TE, Wilson MM, Subar AF, Kahle LL, Tooze JA. Evaluation of the Healthy Eating Index-2015. J Acad Nutr Diet. 2018 Sep;118:1622-33.
116. Johnson RK, Driscoll P, Goran MI. Comparison of multiple-pass 24-hour recall estimates of energy intake with total energy expenditure determined by the doubly labeled water method in young children. J Am Diet Assoc. 1996 Nov;96:1140-4.
117. Leech RM, Worsley A, Timperio A, McNaughton SA. Characterizing eating patterns: a comparison of eating occasion definitions. The American Journal of Clinical Nutrition. 2015;102:1229-37.
118. O'Neil CE, Byrd-Bredbenner C, Hayes D, Jana L, Klinger SE, Stephenson-Martin S. The role of breakfast in health: definition and criteria for a quality breakfast. J Acad Nutr Diet. 2014 Dec;114:S8-S26.
119. Pereira MA, Erickson E, McKee P, Schrankler K, Raatz SK, Lytle LA, Pellegrini AD. Breakfast Frequency and Quality May Affect Glycemia and Appetite in Adults and Children. The Journal of Nutrition. 2011;141:163-8.
120. Siega-Riz AM, Popkin BM, Carson T. Trends in breakfast consumption for children in the United States from 1965-1991. Am J Clin Nutr. 1998 Apr;67:748S-56S.
121. Deshmukh-Taskar PR, Radcliffe JD, Liu Y, Nicklas TA. Do breakfast skipping and breakfast type affect energy intake, nutrient intake, nutrient adequacy, and diet quality in young adults? NHANES 1999-2002. J Am Coll Nutr. 2010 Aug;29:407-18.
122. Lyerly JE, Huber LR, Warren-Findlow J, Racine EF, Dmochowski J. Is breakfast skipping associated with physical activity among U.S. adolescents? A cross-sectional study of adolescents aged 12-19 years, National Health and Nutrition Examination Survey (NHANES). Public Health Nutr. 2014 Apr;17:896-905.

123. United States Department of Agriculture FaNS. HEI Scores for Americans. Average Healthy Eating Index-2015 Scores for Americans by Age Group, WWEIA/NHANES 2015-2016. 2016.
124. French WW, Dridi S, Shouse SA, Wu H, Hawley A, Lee SO, Gu X, Baum JI. A High-Protein Diet Reduces Weight Gain, Decreases Food Intake, Decreases Liver Fat Deposition, and Improves Markers of Muscle Metabolism in Obese Zucker Rats. Nutrients. 2017 Jun 8;9.
125. Chaumontet C, Even PC, Schwarz J, Simonin-Foucault A, Piedcoq J, Fromentin G, Azzout-Marniche D, Tome D. High dietary protein decreases fat deposition induced by high-fat and high-sucrose diet in rats. Br J Nutr. 2015 Oct 28;114:1132-42.
126. Wang L, Du, S., Wang, H., Popkin, B. Influence of dietary fat intake on bodyweight and risk of obesity among Chinese adults, 1991–2015: a prospective cohort study. The Lancet. 2018;392.
127. Chassaing B, Miles-Brown J, Pellizzon M, Ulman E, Ricci M, Zhang L, Patterson AD, Vijay-Kumar M, Gewirtz AT. Lack of soluble fiber drives diet-induced adiposity in mice. Am J Physiol Gastrointest Liver Physiol. 2015 Oct 1;309:G528-41.
128. Adam CL, Thomson LM, Williams PA, Ross AW. Soluble Fermentable Dietary Fibre (Pectin) Decreases Caloric Intake, Adiposity and Lipidaemia in High-Fat Diet-Induced Obese Rats. PLoS One. 2015;10:e0140392.
129. Wang J, Shang L, Light K, O'Loughlin J, Paradis G, Gray-Donald K. Associations between added sugar (solid vs. liquid) intakes, diet quality, and adiposity indicators in Canadian children. Appl Physiol Nutr Metab. 2015 Aug;40:835-41.
130. Bigornia SJ, LaValley MP, Noel SE, Moore LL, Ness AR, Newby PK. Sugar-sweetened beverage consumption and central and total adiposity in older children: a prospective study accounting for dietary reporting errors. Public Health Nutr. 2015 May;18:1155-63.
131. Mattes R. Soup and satiety. Physiol Behav. 2005 Jan 17;83:739-47.
132. Bolton RP, Heaton KW, Burroughs LF. The role of dietary fiber in satiety, glucose, and insulin: studies with fruit and fruit juice. Am J Clin Nutr. 1981 Feb;34:211-7.
133. Flood-Obbagy JE, Rolls BJ. The effect of fruit in different forms on energy intake and satiety at a meal. Appetite. 2009 Apr;52:416-22.
134. Levitsky DA, Pacanowski CR. Effect of skipping breakfast on subsequent energy intake. Physiol Behav. 2013 Jul 2;119:9-16.
135. Hartvigsen ML, Laerke HN, Overgaard A, Holst JJ, Bach Knudsen KE, Hermansen K. Postprandial effects of test meals including concentrated arabinoxylan and whole grain rye in subjects with the metabolic syndrome: a randomised study. Eur J Clin Nutr. 2014 May;68:567-74.
136. Cioffi I, Santarpia L, Vaccaro A, Iacone R, Labruna G, Marra M, Contaldo F, Kristensen M, Pasanisi F. Whole-grain pasta reduces appetite and meal-induced thermogenesis acutely: a pilot study. Appl Physiol Nutr Metab. 2016 Mar;41:277-83.
137. Mollard RC, Wong CL, Luhovyy BL, Cho F, Anderson GH. Second-meal effects of pulses on blood glucose and subjective appetite following a standardized meal 2 h later. Appl Physiol Nutr Metab. 2014 Jul;39:849-51.
138. Lennerz B, Lennerz JK. Food Addiction, High-Glycemic-Index Carbohydrates, and Obesity. Clin Chem. 2018 Jan;64:64-71.

139. Filgueiras AR, Pires de Almeida VB, Koch Nogueira PC, Alvares Domene SM, Eduardo da Silva C, Sesso R, Sawaya AL. Exploring the consumption of ultra-processed foods and its association with food addiction in overweight children. Appetite. 2019 Apr 1;135:137-45.
140. US Department of Agriculture ARS. Distribution of Meal Patterns and Snack Occasions, by Race/Ethnicity and Age. What We Eat In America.NHANES 2015-2016.
141. US Department of Agriculture ARS. Percentages of Selected Nutrients Contributed by Food and Beverages Consumed at Breakfast, by Race/Ethnicity and Age. What We Eat In America.NHANES 2015-2016.

Vita

Matthew Jeans is originally from Kelso, TN, and resided in the surrounding area until 2011. Thereafter, he enrolled in the University of Alabama, where he studied clarinet performance while pursuing a psychology minor and a pre-med concentration. He graduated with University Honors and International Honors, achieved in part from his internship at the Medical Research Institute of New Zealand. Furthermore, he completed the Emerging Scholars Program, a research initiative offered to a select number of undergraduates who begin working in research labs their first year. Following four years of research experiences, Matthew worked as a medical scribe, during which time he took nutritional coursework. In 2016, Matthew entered a graduate program at the University of New Mexico, where he obtained his Master of Music in clarinet performance while holding a graduate assistantship. While there, he pursued independent study with Dr. Peter Pribis, neurological nutrition scientist, from which he was able to design and perform his own study pertaining to injury prevention and treatment and nutrition amongst musicians. After obtaining his Master of Science in nutritional sciences, Matthew intends to earn his PhD at the University of Texas at Austin.